ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

NOVEMBER 23, 1939

...s the breakwater that will protect Chicago's new filtration plant from storms on Lake Michigan.

IN THIS ISSUE: Filtered Water for Chicago . . . New Bridge Pier Design for Deep Overburden . . . Building on Soft Clay . . . The City's Sewage Goes to Sea . . . Bidding Practice of Two Centuries Ago . . . Superhighways and Subways at Chicago . . . Readers Vote "No" on WPA . . . For full contents see page 29.

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READ THESE FACTS PUBLISHED IN A RECENT ARTICLE

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Almost 3.0 million gallons per day of this was eliminated by caulking the joints for a distance of 7,628 feet. This operation cost the city $7,476 and required two years for completion."

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THIS WEEK

● Chicago has begun work on its first big plant to improve the quality of water taken from Lake Michigan. Built off shore on made land, the project calls for some interesting protective works in addition to the normal equipment of a water purification plant.

● Beginning in this issue is the first of three articles on large outfall sewers, a subject on which up-to-date information is scattered and hard to find.

● Summaries of two voluminous reports on superhighways and subways planned for Chicago are given on p. 56. Federal aid for the present subway work is predicted in adoption of a master plan for rapid-transit facilities.

● An elevated water tank is a common type of structure—but when one is built that stands 169 ft. high and stores 1½ million gallons of water it becomes news. The Batavia, N. Y. tank described on p. 60 is one of the biggest and highest in the country.

● News that the famous Hawkesbury River Bridge in Australia must be rebuilt, as given on p. 58, draws attention to the fact that the bridge was built 50 years ago by American engineers who carried one pier to the unprecedented depth of 162 ft. below water level.

● Reader votes on the question "Should WPA Continue in Construction" are summarized on p. 59. Abstracts from a wide variety of letters on the same subject are given on p. 38.

● Novelty in building foundations is reported in the article on the New England Mutual Life Building in Boston, p. 52, and in bridge foundations in a description of the piers for the Missouri River Bridge at Brownville, Neb. p. 47.

THINGS TO COME

BEGINNING Dec. 7, a series of articles on present-day thinking with respect to divided highways.

Also in the Dec. 7 issue will be a report on the effect of a recent abnormal rainfall in the area south of Boulder Dam.

LOOKING FARTHER AHEAD, the Annual Highway Number will be Jan. 18.

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Up to 64 feet of clear width and any desired length of floor space is obtainable with Truscon "CLERESPAN" Steel Joists in all types of light load bearing buildings. • Note the absence of obstructing columns in the above photograph of a garage erected recently for a large department store in Cleveland, O. • Note also that pipes and conduits can be run in any direction through the open webs of Truscon "CLERESPAN" Joists. • Used with equal efficiency for floor and roof construction, Truscon "CLERESPAN" Steel Joists are quickly and easily installed and provide strength, safety and fire resistance. All-inclusive economy is another important advantage.

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ENGINEERING NEWS-RECORD

NEWS

Volume 123 NOVEMBER 23, 1939 Number 21

Michigan Town Loses In Pollution Case

An injunction was denied the city of Niles, Mich., Nov. 13, against enforcement of an order by the Michigan Stream Control Commission requiring that city to cease pollution of the St. Joseph River. The ruling was made by Circuit Judge Carr.

The rejection of the injunction is believed to have cleared the way for the state of Michigan to take action in the federal courts against the state of Indiana, with South Bend, Mishawaka and Elkhart as co-defendants, to seek a federal mandate requiring these three cities to cease polluting the St. Joseph River with sewage.

The interstate litigation involved may be offset by a start within a few weeks on the first unit of an interceptor sewer system by South Bend with the assistance of a $78,569 WPA labor grant. Eventually it will connect all existing sewers now emptying into the St. Joseph River with a treatment plant to be constructed northwest of the city. Cost of this unit will be $116,147, of which the city is contributing $30,120 for engineering supervision and materials.

Plans for a second unit of the South Bend interceptor sewer system are being delayed until Mishawaka decides whether it wants to connect its proposed sewage system with South Bend's.

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Injunction Sought in Texas Against Salt Pollution

In the 116th district court in Texas a permanent injunction has been asked by the state attorney-general to halt pollution of the Neches-Angelina River system by salt water from the East Texas oil fields. The suit was instituted as a result of reports by the Texas Board of Health and the State Game, Fish and Oyster Commission.

The state attorney-general alleges that the escape of salt water is not a natural flow but an artificial discharge.

Grand River Authority Seeks to Discharge Wright

The board of directors of the Grand River Dam Authority has asked for the removal of R. V. L. Wright, general manager. Wright was selected as general manager for the project by Secretary Ickes when Ickes was head of the PWA.

The board has charged that Wright is failing to push the project to satisfactory speed. A hearing on the charges has been set for Dec. 1 at Vinita, Okla.

The Grand River project was originally scheduled for completion on Jan. 1, 1940. However, indications are that the project will not be completed before the late spring or early summer of 1940.

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Court Favors Buffalo In Gravel Case

The New York state court of appeals has ruled that the judgment obtained by the Squaw Island Freight Terminal Co., Inc., against the city of Buffalo for damage to its Squaw Island gravel deposits in the Niagara River should be reduced from $497,000 to $92,000. The ruling ends 8 years of litigation.

A supreme court judge in 1938 ruled in favor of the company. When the case was taken to the appellate division, the city was favored and the company started action in the court of appeals, this court affirming the decision of the appellate division.

• • •

$11,800,000 Road Fund Sought in New Jersey

Highway funds totaling $11,800,000 are being requested by the New Jersey State Highway Commission for 1940, according to a report by E. Donald Sterner. He estimated next year's revenues at $46.000,000.

The $11,800,000 budget does not include the cost of new roads.

Building Prospects Aired at Conference

Washington meeting discusses war, housing, costs and labor problems.

Private building, its problems and prospects, was the subject of a construction industry conference in Washington, D. C., Nov. 16 and 17, which was pervaded throughout by an atmosphere of optimism. Attended by some 200 contractors, labor leaders, manufacturers and government officials, the conference, called by the Chamber of Commerce of the United States, heard the speakers praise conditions in the small house field while emphasizing the continued small volume; predict a moderate rise in construction next year despite the slacking off of PWA financing; and agree that the effect of war on construction will not be spectacular either on the up or down sides. Lectures and roundtable discussion also brought jurisdictional disputes and apprenticeship training

(*Continued on p.* 37)

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South Dakota Project Approved by President

The proposed Rapid Valley irrigation project in South Dakota has been approved for construction by President Roosevelt. The project, which calls for irrigating 12,000 acres at a cost of $2,470,000, is the third of the so-called "relief" irrigation projects approved for the Great Plains area. The work is to aid rehabilitation and stabilization of the area.

A dam will be constructed and maintained by the Bureau of Reclamation, and the Department of Agriculture will arrange for final settlement and operation of the project. An earth and rock fill structure 157 ft. high and 1,100 ft. in crest length would be built to provide storage of 40,000 acre-ft. of water.

Federal Claims To Water Challenged

National Reclamation Association holds that states should control waters of western rivers

Asserting that the federal agencies are making claims to all unappropriated waters of western rivers, even non-navigable streams, the National Reclamation Association, at its annual meeting held in Denver, Nov. 14–16, urged Congress to require all federal agencies to comply with state laws relating to the ownership, control and administration of waters in the western states. The association also challenged the claimed right of federal agencies to control the return flow from federal irrigation projects.

The association asked the federal government for more equitable interest rates and amortization payments on irrigation projects financed by agencies other than the Reclamation Bureau.

Similar aims

The aims of the U. S. Bureau of Reclamation and of the Corps of Engineers lie along parallel paths, said Major General Julian L. Schley, Chief of Engineers, in speaking of the reported conflict between these two federal agencies in the development of western rivers. Both agencies, he said, deal with the use and conservation of water. Closer cooperation should result in benefits to all because some flood control projects may develop incidental benefits to irrigation while some irrigations projects can aid in flood control. Schley said that through close cooperation the experts of the two agencies could make into a unified whole each water conservation project undertaken by the government. John C. Page, Commissioner of Reclamation, said that without intelligent use and control of water in dry regions the value of related projects will be reduced.

Over 1,000 representatives from 17 western states were present at the convention. Kansas and Oklahoma were admitted to membership this year. The 1940 convention of the association is to be held in Great Falls, Mont.

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Magnolia, Ark. Buys Water Distribution System

The city of Magnolia, Ark. has purchased the city's water distribution system from the Arkansas Power & Light Co. for $91,500.

The sale has been approved by the state utilities commission, the city to pay $61,500 in cash.

Cable Break Drops Bridge Into Rio Grande

Special Correspondence

Collapse on Sunday, Nov. 12, 1939, of the highway suspension bridge over the Rio Grande between Hidalgo and Reynosa, Mexico, was the result of the parting of the two cables in the anchorage on the Mexican side of the river, according to informal opinion.

Seven automobiles were on various parts of the structure at the time of collapse, but of these only two fell into the river. Four cars were near the American approach and one car on the Mexican approach, and all of these came to rest well above the water and with but slight damage. One car went down with the structure in the deep water at the center of the river and one fell into shallow water near the Mexican bank and was only partly submerged. The one casualty was the driver of the car that fell into deep water.

Suspension Bridge Over the Rio Grande, Hidalgo, Texas, After Failure

The Hidalgo bridge was of the unstiffened suspension type, with parallel steel wire cables supported by two steel towers on concrete piers with driven piling foundations. It had a center span of 450 ft., and a roadway width of 16 ft. The roadway was constructed of wood planking supported on steel floorbeams and stringers.

The bridge was a toll structure owned and operated by the Valley Bridge Co., of Hidalgo, Texas, a Texas corporation. It is one of the most important crossings on the Rio Grande, the nearest crossing upstream being fifty-two miles and downstream thirty miles. Built in 1926 by contractors, and without independent engineering service, it had carried a large volume of traffic and was considered a safe and adequate structure. In 1933, the bridge suffered an accident due to failure of the pier on the American side caused by a flood. Reconstruction of this pier was completed in 1934 (*ENR* June 14, 1934). The present accident caused no damage to the piers and towers.

The initial collapse was caused by a tensile failure of the upstream cable which occurred deep in the anchorage. As this cable failed it broke off the upper part of the concrete anchorage in a huge block which jumped through the air about 60 ft. toward the river before dropping to the ground. As the upstream side of the structure fell, the resultant overloading of the downstream cable also caused a tensile failure of this downstream cable deep in its anchorage. This latter failure was rather slow, and eyewitnesses stated that the structure settled into the water gradually after the initial upstream cable failure. The downstream cable also broke off a large block of concrete, but this did not spring into the air but was dragged along the ground for some 60 ft. toward the river.

Preliminary investigation revealed that the failure was likely caused by electrolysis attacking the wires composing the cable. Due to the failure occurring deep in the anchorage where the inspection was impossible, without removal of the anchorage concrete encasement, it was not revealed during the regular periodic maintenance inspections of the structure.

Limited service is now being maintained through the use of ferry boats. An emergency pontoon bridge will be completed across the river within a few days to restore traffic to its normal flow. The management of the bridge company is now considering plans for reconstruction, which it is said will commence within a short time.

San Francisco Bay Bridge Has $15,300,000 Income

Total revenues from the San Francisco-Oakland Bay bridge, including tolls paid by the electric railway, rents and interest amount to about $15,300,000 since the bridge was opened three years ago. A total of 28,650,000 vehicles has crossed the 4½ mile structure during this period.

Despite the heavy traffic handled by the bridge, 1,000,000 more vehicles having used the San Francisco bridge last year than the George Washington bridge in New York City, there has been only one accident per 762,000 vehicle miles or 175 accidents for the 28,650,000 vehicles using the structure.

The bridge is operated by the Division of Highways of the California State Department of Public Works. It cost $73,000,000.

• • •

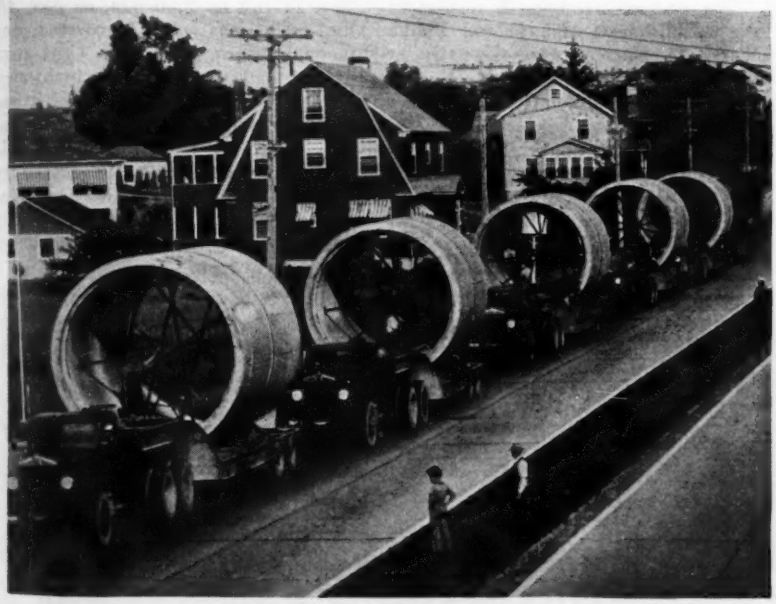
Large Canadian Project Suspended Due to War

Pending the outcome of the present war, the British Columbia Electric Railway Co. has temporarily suspended plans to proceed with a million dollar auxiliary steam plant at Brentwood Bay near Victoria, B. C.

Rappoport Photo

ASSISTANT TO ZONE ENGINEER OF PENNSYLVANIA RAILROAD

JOHN M. NICHOLSON, assistant engineer, has been promoted to the position of assistant to A. C. Watson, the chief engineer of the New York zone of the Pennsylvania R. R. system. Following graduation from Columbia University in 1903. Nicholson joined the staff of the Long Island R. R., a part of Pennsylvania system, as a draftsman. Nicholson now is in charge of the Atlantic Ave. grade separation job of the Long Island in Brooklyn.



PIPE FOR QUABBIN DAM PROJECT AT BOSTON

SIX 12-ft. lengths of 84 in. concrete pipe are shown on Sterling diesel powered tractor-trailer units en route for use near Quabbin Dam to supply additional water for the metropolitan area of Boston. A series of radial jack struts inside the pipe minimize deflections of the heavy pipe during handling and laying.

The pipes were built by the Lock-Joint Pipe Co., Ampere, N. J., and the heavy duty 16-wheel trailer units were built by the C. R. Jahn Co., Chicago.

No License Needed For Virginia Plant

U. S. Court of Appeals holds that New River is not a navigable stream subject to federal control

The U. S. Court of Appeals, fourth circuit, has denied the Federal Power Commission the right to require the Appalachian Power Company to apply for a federal license to operate its power plant on the New River, near Radford, Va. Indications are that the commission will seek a review of the decision by the U. S. Supreme Court.

Hearings in the long-fought battle between the commission and the power company were heard at Asheville, N. C., Aug. 28-30 (*ENR* Sept. 7, 1939, p. 314), the case centering around the refusal of the company to apply for a federal license for the project (now completed and in operation). The commission sought the injunction when the company started work on the dam in 1934.

District court upheld

In denying the commission the right to require a license, the circuit court of appeals upheld a decision of the U. S. district court for western Virginia. The district court in 1938 reversed the commission's order requiring the company to take out a license (*ENR* Apr. 28, 1938, p. 604). The court held that the New River is not navigable and therefore, is not under the jurisdiction of the federal commission.

The commission had sought jurisdiction of the stream on the grounds that the New River flows into the Kanawha River in West Virginia, which is navigable, and on the grounds that a dam on the New River would interfere with the navigability of the Kanawha. This contention was denied by the power company, which claimed that the New River is not navigable interstate from Virginia and West Virginia and that the dam does not affect the navigability of the Kanawha.

The Court of Appeals in its opinion held that the power commission's jurisdiction with respect to dams on non-navigable streams is limited to cases where interstate commerce is affected in matters of navigation.

Both the states of Virginia and West Virginia have entered the case to protect their rights in the matter, each contending that the federal government has no jurisdiction over the stream. The case is important in that it will decide whether the federal government may have jurisdiction over non-navigable streams just because they are tributaries to navigable rivers.

New York Engineers Plan Law Changes

Professional society drafts proposed changes in state license law for engineers

Numerous changes in the New York license law for engineers and land surveyors were approved in preliminary draft form at the fall meeting of the New York State Society of Professional Engineers held in Rochester November 17-18. The proposed changes are designed chiefly to clarify the law and eliminate present sources of confusion.

Among the proposed changes is one to clarify the definitions of surveying work done by engineers and by land surveyors to eliminate confusion as to the field of each, also changes to strengthen the restrictions against filing of "descriptions, maps and other engineering documents," by other than licensed engineers or land surveyors.

A proposed amendment to the license law, calling for a paid secretary for the license board, not a member of the board, was approved. The salary of the secretary is to be not less than $5,000, payable from the license fees. Also approved was an amendment to the civil practice act, which calls for an increase in the statutory fees for licensed land surveyers in "action for partition or dower" from $5 a day to $25, and for assistants from $3 to $8.

Educational requirements

Proposal to revise the educational requirements of the law to permit the substitution of two years of post graduate study for two years of practical experience were to have come before the meeting for consideration, but were withdrawn at the last moment due to the strong opposition that has developed to this proposal. The same proposal included a change that would permit candidates for a license to take their examination before obtaining the required amount of practical experience. As that proposal seems to have wide support the legislative committee was instructed to revive a bill implementing only that proposal which was passed by the legislature two years ago but failed to receive the Governor's approval. A proposal to eliminate separate licenses for land surveyors was set aside as being a long-range objective rather than one calling for immediate action.

License racket

Reporting for the committee on ethics and practice, D. B. Steinman, chairman, stated that a man in New York recently offered to provide unlicensed engineers with a license as an engineer in Delaware (which has no engineer license law) for $20, and for $25 additional to secure a license as a professional engineer in New York State. What he provides is a $10 Delaware business tax receipt. The man is reported to have collected $20 from over 150 victims. The case has been referred to the district attorney.

Federal public works

The present trends with respect to the establishment of a federal Public Works Department were discussed at the luncheon meeting by M. E. Gilmore, regional director, PWA. Other speakers included Frederick H. Zurmuhler, president of the society, Carey H. Brown, superintendent of engineering and maintenance of Eastman Kodak Co., and Dean Lee A. DuBridge, head of the faculty of arts and sciences, University of Rochester.

Numerous Pennsylvania Engineers on Relief

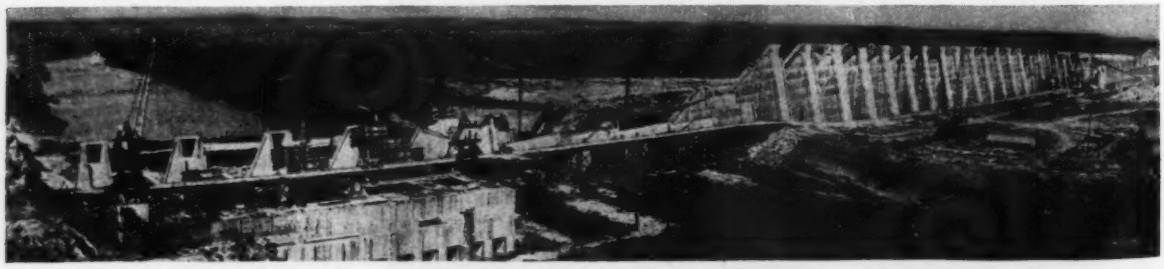
A list of employable persons receiving Pennsylvania relief shows that there are 225 professional engineers on the state's relief rolls, according to the Department of Public Assistance. Also listed are 105 draftsmen and designers; 1,530 crane, dragline and shovel operators; 955 concrete finishers; 585 general construction workers; 390 stationary engineers; 330 construction riggers and 170 structural steel workers.

• • •

Pipe Laying Record At Little Rock, Ark.

Probably the fastest pipe laying job on record was made at Little Rock, Ark., last week where 9,400 ft. of water main was installed and ready to carry water 9 days after the order was given to start work. The installation, of 6-in. asbestos cement pipe, was made to provide water at Camp Joseph T. Robinson, where a detachment of cavalry troops had been ordered for training.

The order to install the main was given late in the evening of Nov. 6 and the next day material was ordered and a contract awarded for digging the trench by machine. Pipe arrived on Nov. 11 and by 2:00 p.m. on Nov. 14, the main was placed, covered and ready to receive water. M. L. Crist, engineer of the Little Rock municipal waterworks supervised the work which was done with funds supplied by local business interests; F. F. Schneider, field engineer from the St. Louis office of the Johns-Manville Corp., supervised pipe laying. Complete details of this record-breaking installation will be published in an early issue.



PENSACOLA DAM RISES ABOVE GRAND RIVER FLATS IN OKLAHOMA

Pensacola Dam on the Grand River in northeastern Oklahoma is now 71 per cent complete, according to a progress report by Holway & Neuffer, Tulsa, consulting engineers on the Grand River project. Massman Construction Co., Kansas City, contractor on the powerhouse and dam, has placed 396,500 cu.yd. of concrete in the dam, with 114,000 cu.yd. remaining. The dam consists of 51 arch sections of 60-ft. span between hollow buttresses, maximum height 152 ft., 860 ft. of gravity section spillway and 450 ft. of nonoverflow gravity section. Auxiliary spillways lie in saddles to the east of the main dam. Massman has finished sixteen of the arches, 22 buttresses and most of the gravity sections. The above panorama shows progress to date on the main dam. The arches, as shown in the center section, will extend across the river to the left behind the powerhouse. The project, being built by the Grand River Dam Authority under a $20,000,000 PWA loan and grant, was described in *ENR* Feb. 16, 1939, p. 64.

Engineers Talk Building To Industrialists

At the Chicago meeting of the American Management Association, Nov. 15 and 16, headline speakers, Albert Kahn and H. K. Ferguson, designers and builders of industrial plants, warned management that new buildings should be undertaken only after study shows that savings or increased profits will result. Once the decision is made in favor of improvements, there is much available today with which management should be familiar.

Kahn described trends to concrete structures with larger panels (up to 40 ft.), and to one-story buildings permitting straight production lines. While Kahn indicated several preferences, such as monitor instead of sawtooth roofs, he said it was foolhardy to generalize or to oppose any one type of construction without attention to all factors. A point was made of the salutary effect on employees of good external appearance. Kahn deplored temporary building except in rare cases.

Factors affecting efficiency

Ferguson stated that while the investment in building is the starting point of any effort to reduce unit costs, the operation of the plant will be affected by other factors such as maintenance, employee efficiency and operating efficiency of building services or trades. Floors are the most abused part of the building and must be built for the service intended. As to bonded versus unbonded roofs it is Ferguson's opinion that a man with tar pot and brush regularly inspecting a roof will do more to preserve it than a printed bond. No substitute, he stated, has yet been developed for masonry sidewall construction.

In the matter of employee efficiency the whole objective, according to the speaker, is to decrease physical and mental fatigue. A practical attitude should be maintained as to cost since it would be foolish to provide expensive air conditioning and lighting where production is fixed by the capacity of the equipment as in sugar refining, tanning and the chemical industries. Controlled temperatures and humidity on the other hand pay big dividends in chocolate candy production. Similarly, air conditioning is vital in the manufacture of rayon, cotton textiles and printing.

• • •

Pipeline Breaks At Colorado Springs

Recently a break occurred in the high pressure pipeline carrying water to the city of Colorado Springs, Colo. The pipeline, which parallels the Manitou-Pikes Peak cog railway, was placed in service Aug. 1 of this year when a $471,000 PWA project was completed. The break occurred where the grade is 68 per cent. No serious damage resulted due to early discovery of the break. A rough estimate of the damage is $5,000.

The pipe at the point where the failure occurred is a 24 in. steel pipe with a 5/8 in. shell. Pressure at the time of the break was said to be 650 lb. per sq.in. The cause of the failure has not been determined.

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Cement Anti-Trust Suit Settled in Texas

As the outcome of anti-trust suits against various cement companies operating in Texas, the San Antonio Portland Cement Co. and the Longhorn Portland Cement Co., will each pay a penalty of $50,000, and together with the Gulf Portland Cement Co. will stop fixing prices, lessening competition and restraining trade within the state of Texas.

Flood Control Work Defended

Brief in Supreme Court points out constitutionality of Denison Dam project

Constitutionality of the federal flood control program, and particularly of the Denison Dam project, is defended in a brief filed last week in the U. S. Supreme Court by Solicitor General Jackson. The brief is a reply to an attempt by the state of Oklahoma to enjoin the Denison project.

Chief reliance for justification of the flood control program is placed on the general welfare clause of the Constitution. The brief points to the great damage done annually by floods and asserts that the Denison project is an integral part of the Mississippi protection system.

The commerce power is also invoked on the ground that navigation in the lower Red River will be improved, though the river is admittedly non-navigable at the damsite. It is also pointed out that floods destroy bridges, roads and other instrumentalities of interstate commerce.

To complaints by Oklahoma that the reservoir will flood state-owned lands, will reduce tax revenues, and may be inconsistent with the state water program, the brief replies that it is well established the federal government may condemn state land and that compensation will be paid for any land taken. Reduction in taxes or other interference with state activities, it is asserted, cannot stand in the way of carrying out a valid federal purpose.

Technical flaws in Oklahoma's complaint might in strict law, it is asserted, prevent the court from taking jurisdiction in the case. The brief urges, however, that the court consider the case on its merits in order to obtain a test of the flood control law, which has never come before the high court.

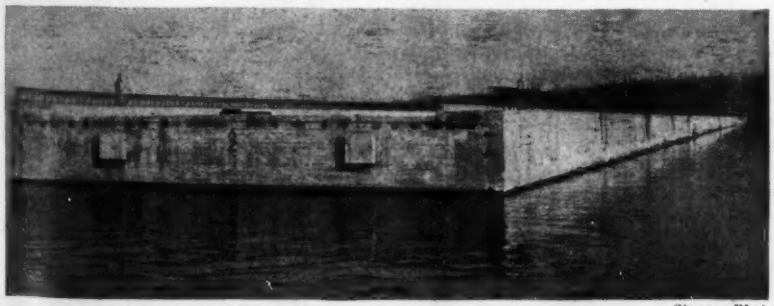
• • •

California Aqueduct Put Into Service

The aqueduct of the Metropolitan Water District of Southern California was put into service Nov. 9 when flow of Colorado River water into the Cajalco reservoir began. The water in being transported 242 miles is lifted 1,617 ft. by five pumping plants.

It will be another year before water can be delivered to the cities.

The ultimate capacity of the aqueduct will be 1,000,000,000 gal. per day, not 1,000,000, as was stated in our issue of Oct. 26, p. 35.



Simmer Photo

LAKE WASHINGTON PONTOON ANCHORED IN LINE

THE EXCELLENT ALIGNMENTS of the concrete pontoons already anchored in place for the floating bridge across Lake Washington at Seattle is shown by this recent view. Projections from the end of the pontoon in the foreground are shear keys. For details of the bridge see *ENR*, Oct. 5, 1939, p. 440.

OBITUARY

WILLIARD C. LAWRENCE, 54, city water commissioner since 1938 at Cleveland, died Nov. 15 in that city. Lawrence had been with the Cleveland utilities department for 32 years and before becoming water commissioner was superintendent of the Baldwin filtration plant.

HECTOR H. GIROUARD, 54, construction supervisor for the Ontario department of highways in the western section of the province, died recently in Little Current, Ont. Following his graduation from the University of Paris, Girouard worked as an engineer on the construction of the National Transcontinental Ry.

FREDERICK NEWTON WILLSON, a graduate with the class in 1879 from Rensselaer Polytechnic Institute with the degree of civil engineering and for the past 43 years a member of the teaching staff at Princeton University, died Nov. 15 in Princeton, N. J., at the age of 83. In 1880 Willson established the department of graphics at Princeton and at that time became its head, a position he held until his death.

JAMES C. CREVELING, JR., 68, first highway commissioner ever appointed in Tennessee, died Nov. 10 at Nashville. Creveling resigned in 1925 after three years of service as commissioner in protest against a plan to use highway funds for a bridge on the Mississippi.

RITCHIE G. KENLY, chief engineer of the Minneapolis & St. Louis R. R. until his retirement last April, died recently in Minneapolis at the age of 73. He had been with the railroad 30 years.

Other recent deaths include: C. C. CORNELL, 39, road contractor, Brantford, Ont.; RICHARD L. BUFFINGTON, 65, civil engineer and chief engineer of the American Gas & Electric Co., Lexington, Ky.; WILLIAM SPRADLIN, 38, head of the construction department of the Arizona General Utilities, Safford, Ariz., Tucson, Ariz.; CORNELIUS V. COX, 56, building contractor, Water Valley, Miss.; LIGOURI LAMBERT, 78, retired building contractor, Kankakee, Ill.; JAMES TURNER, 65, builder and for many years maintenance engineer for the Arizona State Highway Department, Prescott, Ariz.; GEORGE W. LANSTRUM, 65, chairman of the first Montana State Highway Commission, Kalispell, Mont.; FELTON J. KUNKEL, construction contractor, in Kansas City, Mo.; A. P. POROT, 56, civil engineer and road contractor, Belleville, Ill.; JOHN S. SCHWARTS, for the past 10 years highway commissioner of Aurora, Ill.; JOHN J. BROWN, 76, building contractor, Shelbyville, Ky.; JAMES A. WALLACE, 50, plumbing and heating contractor, Des Moines; JOHN J. RUDSER, 75, building contractor, Grand Forks, N. D.; CARL J. VENNEWITZ, 75, building contractor of St. Louis; and FELIX E. LIETZ, 62, paving contractor of Buffalo, N. Y.

Engineers and Surveyors To Register in Maryland

The registration of professional engineers and land surveyors in Maryland has begun under the direction of the State Board of Registration for Professional Engineers and Land Surveyors, as provided by an act of the last session of the Maryland General Assembly.

A. G. Christie, Johns Hopkins University, is chairman of the board and J. R. Baker is secretary.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the short week due to the Thanksgiving Day holiday total $47,655,000, a decrease of 4 per cent from the volume for the corresponding week last year.

The current week's total brings 1939 construction to $2,758,028,000, 12½ per cent above the volume for the 47-week period last year.

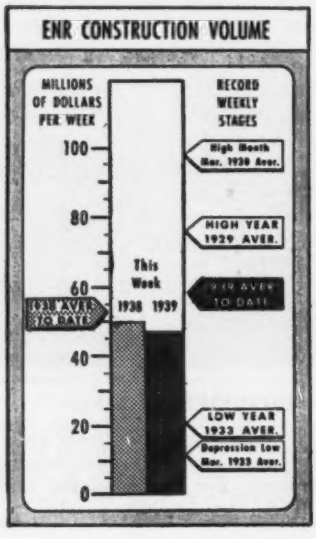
Private awards for the week top the week a year ago by 82 per cent, the eleventh consecutive week that they have exceeded their respective 1938 values. Public construction is 34 per cent below the total for the week last year.

In the classified construction groups gains over the week a year ago are in bridges, industrial buildings, and unclassified construction. Industrial building is the only class of work to report a gain over last week.

New capital for construction purposes for the week, $63,071,000, is 35 per cent above the volume for the corresponding 1938 week. The week's total is made up of $60,748,000 in state and municipal financing, $2,250,000 in corporate security issues, and $73,000 in RFC loans for public improvements.

State and municipal financing is the highest of the year due primarily to the $30,000,000 New York City issue, and $22,944,000 in short term notes for USHA housing project construction in eleven cities.

New construction capital for the year to date, $2,333,620,000, is 34½ per cent lower than in the initial 47-week period last year.



CONTRACTS

(Thousands of dollars)

	Week Ending Nov. 24 1938	Nov. 16 1939	Nov.23 1939
Federal	$3,945	$11,149	$3,041
State & Municipal	33,436	56,478	21,724
Total public...	$37,381	$67,627	$24,765
Total private..	12,589	28,789	22,890
TOTALS	$49,970	$96,416	$47,655
Cumulative 1939 .....(47 weeks)....			$2,758,028
1938 .....(47 weeks)....			$2,452,681

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	1938 47 Wk.	Cumulative 1939 47 Wk.
NON-FEDERAL	$2,416,351	$1,205,592
Corp. securities ...	353,782	198,668
State & Mun.....	594,856	517,905
R.E.A. loans.....	67,495	89,445
R.F.C. loans.....	100,344	7,927
P.W.A. allot.....	833,320	.....
U.S.H.A. loans....	265,054	201,647
Fed. Aid—Hwys...	201,500	190,000
FEDERAL	$1,143,695	$1,128,028
TOTAL CAPITAL..	$3,560,046	$2,333,620

FHA MORTGAGES

	Week Ending Nov. 19 1938	Nov. 11 1939	Nov. 18 1939
Selected for appraisal	$21,751	$19,216	$19,000*
Cumulative 1939 .....(46 weeks)....			$1,024,518*
1938 .....(47 weeks)....			$ 911,237

* Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Nov....	238.20	114.50
Building Cost	Nov....	201.24	108.95
Volume	Oct....	222	97.

Building Prospects

(Continued from p. 31)

in construction into the limelight.

In the opening session on "Construction and American Progress" E. P. Palmer, New York contractor, attacked the prophets of gloom who see in a slowing down of population growth a permanent slowing down of construction by private enterprise. Palmer pointed out that families, not population, do the buying and that families are increasing. In the housing field, for example, 450,000 new units are needed annually to take care of new families. These houses, said I. N. Tate, Weyerhaeuser Sales Co., another speaker, can be built for less than the average price over the past 20 years and may be financed much more cheaply and soundly than ever before. That Palmer's 450,000 new families will need houses was emphasized by Tate's statement that there are only 1 per cent vacancies in present single-family houses.

Slum clearance

Practically nothing is now being done either publicly or privately towards clearing slums or providing satisfactory housing for the low-income population, according to Walter R. McCornack, dean of the school of architecture at M.I.T. The crux of the problem is cost. The job of clearing the slums is just too big if it must be done at a cost of $5,000 per dwelling unit. McCornack thinks lower costs can be achieved—costs as low as $300 per room. Such a cost would permit private capital to furnish unsubsidized housing, amortized over twenty years, at a rental of $3.50 per room per month.

Largest contribution to lower costs, McCornack said, would be a thorough overhauling of building codes. Present codes he described as an insult to the intelligence of the American people and probably illegal in that they go beyond the requirements of safety.

Commercial building

Discussion in the field of non-residential construction centered on modernization. In speaking of commercial buildings, Ralph T. Walker, architect, New York, emphasized the importance of the future character of the neighborhood on any modernization decision. Also in Walker's opinion too many modernization programs are undertaken as emergency measures whereas the building owner should plan for continuous modernization the same as he plans for continuous repairs.

Miller McClintock of the Bureau of Traffic Research, Yale University, touched on this problem of commercial building in his talk on "Rebuilding for Traffic." Traffic congestion, he pointed out, brought about branch banking, shifts of commercial districts, and other changes in building development. The breaking up of highly centralized commercial districts has brought about the need for express highways to tie the outlying districts together and connect them with the central district downtown. Widening streets merely increases congestion, and in the place of this expedient Dr. McClintock urged the building of elevated highways at a cost of $400,000 to $1,000,000 a mile. Alfred Rheinstein, New York contractor, former head of the New York City Housing Authority, in discussing Mr. McClintock's paper, suggested a danger from elevated highways in that they tend to accentuate the blighting of interior areas, creating in effect "twin cities"—downtown blighted areas and the outlying suburban areas. Rebuilding for traffic and rebuilding for healthy city growth should go hand in hand, in Rheinstein's opinion.

Construction apprentices

An outstanding event on the program was the roundtable discussion of apprenticeship in the construction industry, handled by E. K. Jenkins, director of vocational education, Structural Clay Products Institute. Contractors, labor leaders and government officials took an active part, and it was evident (1) that each group recognizes its responsibility for training craftsmen, (2) that important progress has been made in those trades which have drawn up apprenticeship standards by joint agreement of labor and employers under the direction of the Department of Labor's committee on apprenticeship; (3) that the inflexible indenture by which an employer takes on an apprentice for a period of five years, is not applicable to construction, a fact which the new apprenticeship standards recognize by permitting transfer of apprentices among contractor employers; (4) that whereas there is now one apprentice to thirty workmen, a 1:5 ratio should be achieved; (5) that government aid in schooling can help train apprentices but only actual work on the job can make them accomplished craftsmen; and (6) that the training idea should be extended to include journeymen as well as beginners, and (7) that the stalemate created when both labor and the contractor are unemployed and thus at a disadvantage in promoting apprenticeship can be removed by drawing up standards that represent an effective compromise.

In an address on jurisdictional disputes, John Coyne, president, Building and Construction Trades Department, American Federation of Labor, stated that in the 45 days since the new procedure for settling jurisdictional disputes has been in effect requests for decisions on jurisdiction have decreased 85 per cent. He expressed confidence that we are finally on the road to the elimination of the stoppage of work through the jurisdictional dispute.

Predictions for 1940

In looking ahead to building in 1940, both Thomas S. Holden, vice president, and Clyde Shute, manager, statistical department, F. W. Dodge Corp., predicted increased volume of private non-residential building, and a decline in public non-residential building. The net result would be a gain of about 3 per cent.

All speakers who discussed the possible effects of war on construction agreed that the result would not be spectacular either in creating a boom or a further falling off in volume. Most speakers agreed that no large rise in materials prices was to be expected.

• • •

Engineers, Building Firm Fined in Minnesota

John T. Flanagan, former administrative engineer with the Minnesota State Highway Department, Peter B. Halvorsen, contractor of Rochester, and the Park Construction Co., Minneapolis, were all fined $1,000 recently when the two men and representatives of the company pleaded guilty to violation of the state's corrupt practices act. The action came about as part of an investigation of illegal payments of campaign contributions during the last Minnesota state political campaign.

Motion for a new trial in the case of L. L. Allen, former Minnesota State Highway Department maintenance engineer, has been made in the Ramsey County district court. Allen is under sentence to serve a maximum of five years for false payment of $60,000 in state funds as rental for equipment which was never used on the Beaver Bay road project as claimed by Allen. Motions for new trials for N. W. Elsberg, former Minnesota state highway commissioner and S. J. Reader, Minneapolis contractor, have already been denied. Elsberg and Reader were convicted on the same charges as Allen, Reader now being in jail. Elsberg will appeal to the state supreme court.

• • •

Irrigation of 25,000 Acres Planned in Mexico

The ministry of communications and public works in Mexico is completing plans for the irrigation and fertilization of 25,000 acres in Yucatan State, Mexico's principal henequen producing zone.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Tremie Concreting in Slurry

Sir: Referring to the article on "Clay Augers Sink Foundation Wells" in Engineering News-Record, Oct. 12, p. 473, it is noted that similar digging machines developed by W. J. Newman were used by the Great Lakes Dredge & Dock Co. in 1936 to sink caissons in building the Wacker Drive and the Field Boulevard for the Chicago Outer Drive Improvement. Similar lining was used down to and into a good stiff clay, the remaining distance to rock being sunk by the usual wood-lagging method.

In regard to tremie concreting in a hole full of slurry, I believe good results can be obtained if an 8-in. tremie pipe is used and if the bottom is kept constantly in the concrete mass with absolutely no water in the pipe. The weight of the concrete mass will force every particle of the slurry upward. The tremie should be jiggled slightly by a line attached to an electric winch. If a cheap pipe is used, such as second-hand spiral pipe in short sections with flange ends, the sections can be quickly installed and the pipe can be burned off as it is brought up. The concrete should be a rich mix of 1:2:3 for 3,000-lb. design. Similar experience with tremie in wet holes full to the top and with some sand showed about 5 ft. of good sand and cement concrete on top of the pour. When the top sand-and-cement concrete was cut down to a good concrete, tests made of samples showed high compressive strengths.

A. B. WANG
Department of Subways and Traction
Chicago, Ill.

On Using Advertisements

Sir: It is obvious to most subscribers to trade and technical periodicals that the publication cost of an issue is many times the subscription price. The difference between cost of production and receipts from subscriptions is met by the income from advertisements. Whatever merit our technical magazines possess, in fact their very existence, is largely due to those who advertise therein.

It is said that the reading matter of the advertisements in engineering papers is 99 per cent truthful. These advertisements have a definite educational value which is attested to by the fact that the best technical libraries bind the advertising sections of leading periodicals in separate volumes and give them a place on the shelves.

Every reader of a technical paper should read the entire advertising section. The writer has adhered to this practice with beneficial results for over half a century.

ROBINS FLEMING
Structural Engineer, (retired)
New York, N. Y.

WPA in Construction

Sir: The articles pro and con on the WPA, respectively by Col. F. C. Harrington and W. A. Klinger, in your issue of Aug. 31, 1939, were very interesting. It seems to me that both authors failed to mention directly one very important factor in this problem. This is the matter of personal financial responsibility in any business venture. It appears to me that the shortest cut to efficiency in business is to have an individual or a group of individuals financially responsible for the business. In the construction business this reasoning would lead directly to the conclusion that work should be done by the general contracting method.

There still would be two classes of labor to be cared for—the skilled mechanics who have slowed down because of age or other causes and whom the general contractor cannot afford to hire under the high fixed wage scale now demanded by organized labor; and the young people who have come of age in recent years and have had no opportunity to master skilled trades. Both Col. Harrington and Mr. Klinger, as do all other responsible citizens, recognize the duty of providing for these classes.

I believe that a work program is better than direct relief. I further think that such programs should be administered directly by the states with the state organizations responsible to the federal government. Furthermore, such programs should not be permitted to compete with regularly established business but should be recognized for what they are, namely, relief work.

This statement should not be interpreted to mean that good work cannot be done under the WPA system. I have had responsible executive charge of about three quarters of a million dollars worth of WPA work and I know that this work was the equal in quality to any contractual work of which I have had responsible charge.

THOMAS F. CHACE
Consulting Engineer,
San Francisco, Calif.

Sir: A person familiar with the construction business can readily appreciate the viewpoint of each of the authors but there is much that is pertinent to the question which neither of them mentioned. Many of the charges made against WPA are true, but it does not require an F.B.I. sleuth to bring to light contractor-built buildings which were sloppily and expensively constructed.

WPA has taken unskilled labor and trained it in many cases until it compares favorably with the run of the mill mechanics of the community. It has regularly produced stone work superior to that turned out by contract work. It has turned out concrete work which rates superior to contract work, although in other cases, especially the smaller jobs, some of its work has been rotten. As between the work done under WPA and that done privately, the WPA work is better designed, in Kentucky at least, than is much private work.

The writer has spent about 30 years in the construction industry, at least 25 of which have been from a contract angle; has spent 3½ years with WPA as resident engineer, traveling engineer and chief building inspector on various projects; and for the past two years has been engaged in the design and supervision of public construction generally built by WPA. I am in a position therefore to know whereof I speak when I say that WPA fills a real construction need, particularly in the poorer sections of the country.

I can see no need for WPA building projects costing $150,000 or more, but there is no need of contractors or labor unions kidding

themselves that WPA as carried on in the rural sections is taking any bread and butter out of their mouths.

IRA A. BUTCHER
H. A. Churchill & Associates
Lexington, Ky.

Sir: If in your WPA discussion you mean construction of complicated works, my vote is "no"; if you mean such work as road grading and culverts and small projects, my vote would have to be "yes and no." I was supervising engineer for WPA from Aug. 19, 1935, to Nov. 15, 1936, and feel somewhat qualified to give an opinion on the question you have submitted. In Mr. Klinger's seven points called "The Case Against WPA" I have the following opinions:

Point 1. "Extremely wasteful and uneconomic"—true.

Point 2. "Bent on self-preservation"—true.

Point 3. "Ruinous to the morale and desire for accomplishment of workmen"—not in all cases.

Point 4. "A politically subversive force"—absolutely true, as I know that all administrative employees in the Wichita 4th district were required to contribute 5 per cent of their salaries, and my own connection with WPA was ended after I had refused to donate $100 for the Democratic Party campaign fund.

Point 5. "A violation of every concept, etc."—not true.

Point 6. "A devastating government, etc."—not quite that bad.

Point 7. "A retardant to recovery, etc."—not true.

RICHARD R. MCFADDEN
Kingman, Kan.

Sir: My experience is that only about 2 per cent of relief employees actually perform their work in a creditable manner, trying to actually earn their wages. For example, a 30-in. sewer was laid across my property after I had deeded the necessary land. The workmen cut off most of the fence posts and left the wire lying where it happened to fall; as the pipe came along they used 14 men at the car door to load the two trucks doing the hauling; at the delivery end of the line they used homemade cranes and had 18 men to unload the trucks. Each 30-in. 3-ft.-long pipe section weighed 645 lb. I could not help but remember ten years earlier, under a contract let by competitive bids, I had charge of construction of a 36-in. sewer, where one good stout man hauled out and distributed these larger and heavier pipes three at a clip, each 3-ft. section weighing 1,100 lb., taking same from car door and after hauling five miles unloaded without any other help than that which common sense and a little knowledge of mechanics suggested to him.

In the actual laying of the sewer through my lands, two men performed the greater part of the labor of excavation and placing of pipes, while the other 46 men simply killed time or barely placed one-quarter of a shovel of backfill six times per minute by actual count. This was the most flagrant abuse of government generosity with which I have come in contact.

J. W. DAPPERT
Consulting Engineer
Taylorville, Ill.

Sir: My experience in the last half-century as an engineer and manager of construction firms leads me to agree fully with Mr. Klinger. Construction cannot go forward and be at its best with government in the construction business. My experience as an engineer in the past eight or nine years with the CWA and WPA is that the relief given us afforded only an existence, that most families had to resort to bread cards, and that it has lowered the morale of both men and women. Not only does it give jobs to men and women who are not fit to work and should be on direct relief, but it costs from 100 to 200 per cent more than contract work, while the WPA worker is paid from 25 to 50 per cent less per hour.

J. A. MOELLER
Engineer and Contractor
Rockwell City, Iowa

Sir: In your WPA discussion we have the spectacle of a spokesman for the construction industry asking that subsidies for workers be discontinued but at the same time asking that subsidies for employers be continued through a Public Works Administration. And while the construction industry was being helped by PWA and other governmental spending to a point where the private contractors were almost as well off as they were before the skyrocketing years of 1925 to 1929, the industry has continued to close its employment-office doors to several million people, able and willing to work but over forty years of age. The complainant in your recent controversy suggests that these cast-offs of industry should "look for work" instead of taking jobs with the WPA. How absurd it is for any employer in the construction industry to suggest that some other employer will engage men whom he lays off because of age. Certainly some government agency such as the WPA must create jobs which will employ these men.

H. C. SAWYER
Lakeport, Calif.

Sir: Mr. Klinger's position outlines our attitude. We know there has been and is a relief problem. The CWA, FERA, and WPA may have had a place in an emergency, and some types of work, not competitive with private industry such as cleaning of ditches, soil erosion control, etc., either were or could have been of value—as an emergency measure. However, while avoiding criticism of any individuals, we feel it is not in the nature of such an organization to operate on a basis of caring for the real need only—and that was the basis on which it was set up. Instead it tends to expand and to become more permanent and to enter new and greater fields.

What is the effect? Consider the charts you published Oct. 6, 1938, being the U. S. Department of Commerce comparison of men normally employed by various industries as shown in the 1930 census. With construction (outside of agriculture) having more than twice as many men as its next competitor (railroads) this country cannot fully recover without the construction industry being part of that recovery. To throw WPA men from all walks of life into construction defeats construction recovery. To make a construction worker go onto relief in order to get a job because the WPA has undertaken a construction project on which he would normally be working defeats recovery.

Looking at the problem from any angle, we cannot see that WPA should continue in construction.

STEPHEN D. BUTTS
President
Michigan Construction Federation
Detroit, Mich.

Correction

The Pittsburgh-Des Moines Steel Co. fabricated the steel for the Bankers Life Building, Des Moines, Ia., described in the article in our issue of Oct. 26. The statement on p. 63 that the steel was fabricated by the Jones & Laughlin Co. was an error due to a misunderstanding on the part of the editors.

ENGINEERING NEWS-RECORD

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NOVEMBER 23, 1939

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WHEN LABOR JOINS with other interests in recognizing and working out an industry's problems, much occasion for strife is removed. Such joint consideration has long been the announced objective of labor leaders but only rarely has been achieved. The attempted approach through establishment of a governmental Coordinator of Industrial Cooperation some years ago was a flat failure. A real step forward was taken last week when a group of construction labor leaders attended the Construction Conference of the Chamber of Commerce at Washington and joined in discussion of apprentice training and jurisdictional disputes. Both are matters of vital concern, to the public as much as to the industry. Establishment of sound apprenticeship plans necessarily depends on close cooperation of labor and employers. Jurisdictional disputes, worst evil of the industry, are primarily labor's responsibility, and it was gratifying to learn that labor will fight the evil consistently and that some progress has already been made since the Atlantic City agreement. Many other problems of construction should yield similarly to cooperation.

New Technical Resource

STEEL PILES found an interesting extension of the valuable use to which they have been applied during recent years in building pier foundations through deep sand bottom overlying rock, in the pile-cofferdam foundations of the Brownville Bridge piers described this week. Like the ingenious application of steel tube shafts to the support of bridge piers in the Cuyahoga Valley deep clay (*ENR*, Oct. 26, p. 541), they are good examples of what resourcefulness and ingenuity can accomplish with modern materials and tools. Steel pipes and piles used as columns below groundwater level have the combined advantages of rapid placement by driving, high load capacity, dependability and permanence, and because of these advantages they showed large economy over caisson construction in both the instances cited. These applications, however, do not exhaust the resources of present-day steel sections and heavy drivers, and further advances in foundation work through their use may be looked for.

A Big Job Completed

COMPLETION OF HYDRAULIC FILLING at Fort Peck Dam marks the end of the most stupendous construction project of its kind ever attempted. Never before, and perhaps never again, will 123 million cu. yd. of material be moved into a single structure. The volume of earthwork thus piled up creates a barrier across the Missouri River 4½ miles long, 250 ft. high and over 4,000 ft. thick through the base. The economics of the whole project has been ridiculed and the design of the dam has been criticized, but from start to finish there has been nothing but the highest praise for the construction procedure worked out by the staff headed by Lt. Col. Thomas B. Larkin and Major Clark Kittrell. As the dredges were the controlling elements in this great earth-moving operation a special note of praise is due William Gerig, who designed the four that did such an admirable job that it was found possible to raise their output to twice what it was expected they could do when they were built.

Federal Control Checked

EFFORTS of the Federal Power Commission to extend federal control to include every major stream in the country received another severe setback last week when the U. S. Court of Appeals denied the right of the commission to require the Appalachian Power Co. to apply for a federal license for its power on the New River near Radford, Va. The act setting up the commission finds its origin in the federal government's right to regulate interstate commerce. Originally, only those power plants that were on navigable streams were held to be subject to control by the Federal Power Commission, but in recent years the commission has held that its powers extended to streams flowing into navigable rivers on the assumption that changes in the flow of those streams might have an adverse effect on navigation in the stream below. Obviously, that theory could be expanded to bring every important stream under federal control. Last year the U. S. District Court for western Virginia denied the soundness of that theory. Now the U. S. Court of Appeals has expressed the same view. Doubtless the case will

go on to the Supreme Court. Since it began its long court history it has increased in importance because the same theory lies back of much that is being attempted under the Flood Control Act.

Vote on WPA

A STRONG VOTE against WPA construction is returned by the engineering public (p. 59 of this issue), voting on the pros and cons presented Aug. 31 by Administrator Harrington and A.G.C. Past-President Klinger. Every group turns thumbs down, even federal and state engineers. But even among contractors many say that they fully recognize the great amount of lasting good done by WPA in improving the country as well as in putting men to work. By voting "No" they assert that the harm done by the methods used outweighs the good. Public opinion applauds the WPA idea but condemns the way in which it is carried out.

Fifty Years' Evolution

FIFTY YEARS AGO Chicago entered into the revolutionary undertaking of purifying its lake water supply by diverting its sewage to the Mississippi, through the formation of the Chicago Sanitary District. On Nov. 6 the district celebrated this noteworthy semi-centennial by inaugurating its new Southwest sewage treatment plant, largest in the world. The half-century's span witnessed amazing developments in sewage disposal, and the sanitary district played a decisive part in this progress.

The original project of disposing of all the city's sewage by westward diversion and resulting dilution by the waters of the Illinois and Mississippi rivers came to completion 17 years ago, after an expenditure of 125 million dollars. The second stage of the enterprise then followed, namely purifying treatment. As now completed the treatment plants are handling a sewage flow of 1,258 mgd, the dry-weather flow of 61 communities in the district's 442 square miles, at an investment cost of 163 million dollars.

On the occasion of this anniversary it is appropriate to recall that much of the contemporary progress of sewage treatment through the half century has been exemplified in the district's work. Dilution was the prevailing method of disposal for years after the district's organization. The rise of treatment thereafter is reflected in the district's studies, begun 30 years ago with the historic 39th St. experiments carried on by Langdon Pearse and his associates. Since that time every new method has been tried out. Thus the Sanitary District served as guidepost to engineers in their work of improving the sewage-treatment art.

Oxidation methods received early attention. Dozens of expedients, from slate filters and chemical precipitation to activated sludge, went through their test. High-rate biological filters were among the latest methods of promise to be tried. Step by step, processes and plant designs were developed to fit the district's resources, always with caution to save the cost of premature expenditure on what might prove to be an unsuccessful process.

Under trained and experienced direction, this experimentation and research gave little consideration to mystery proposals bearing tongue-tickling names. The experimentation itself was planned for efficiency and economy—test-tube trials followed by miniature equipment such as a 4-ft. tank, and later perhaps a small unit that could treat a million or two gallons per day. If such work showed promise a plant of 15 to 20 mgd would be built and tried out before millions of dollars were poured into a plant to treat a quarter of the city's sewage. Thus the whole system was made into a laboratory.

Secondary problems assumed major proportion in the later days, prime among them sludge handling, the bugbear of sewage treatment and the cause of huge continuing expenditure.

But science and engineering do not make up the district's entire history; political and financial vicissitudes were not wanting. Yet always the engineer occupied the center of the stage, his eye fixed on the problem of transforming physical, biological and chemical findings into concrete and steel operating structures.

National interest put its imprint on the sanitary district's activities. The memorable lake-level controversy and its final adjudication in the U. S. Supreme Court had the stimulating effect of advancing the completion of the district's treatment program by 15 years from the originally contemplated date of 1955. Again, when in 1932 the depression disrupted the program for accomplishing early complete treatment, PWA funds in due course came to the rescue.

Now the district enters its second half-century, its primary problems solved but work of fully equal importance remaining ahead. Operation and maintenance, gathering of further experience, refinement of process, and continued study present an engineering and administrative challenge that should make the coming half-century no less notable than that now concluded.

FIG. 1. THE SOUTH DISTRICT FILTRATION PLANT IS TO BE BUILT ON MADE LAND IN LAKE MICHIGAN.

Filtered Water for Chicago

LORAN D. GAYTON
City Engineer, Chicago, Ill.

Contents in Brief—Work on a plant to filter one-third of the water supply of Chicago has been under way for several months. Designs are not complete for the entire project but this article presents basic data, gives some of the principal features and reports progress on one of the world's largest rapid sand filter plants. The plant is being built offshore and is enclosed in a bulkhead protected by a breakwater. Settling basins are double deck and are on piers anchored to the rock. Two raw water supplies are provided.

THE FIRST WATER FILTRATION PLANT for Chicago is to be located on the Lake Michigan shoreline between 75th and 79th streets on the south side of the city. When completed the entire project will cover 150 acres. It will consist of a breakwater, a bulkhead inclosing the 38-acre site of the 320-mgd filtration plant proper and 115 acres of filled-in land forming a beach and park. The project also includes 2 miles of 16-ft. tunnel in rock in two sections; one section supplying raw water from the Edward F. Dunne crib to the filtration plant and the other section taking the filtered water from the plant to the existing tunnel system. A second means for obtaining raw water is provided in the form of intake ports in the lake side of the substructure.

In August, 1938, the PWA approved a 45 per cent grant for $12,000,000 of work in connection with this project, which is estimated to cost $20,000,000 ultimately. The grant program, to be completed by June 30, 1940, includes the breakwater, the bulkhead, the beach and park fill, the filtration plant tunnels and the substructure of the plant. It also included the installation of 50,000 water meters, but under a subsequent agreement the installation of the meters has been postponed until the completion of the filter plant.

Unusually large capacity

The plant is being designed for an average annual delivery of 225 mgd and an hourly peak of 450 mgd. At the nominal rate of 125 mgd per acre (2 gal. per sq. ft. per min.) the plant capacity is 320 mgd, making it one of the largest yet built. It will supply filtered water to three south side pumping stations, the Roseland, 68th St., and Western Ave. The area within the city limits to be served by this plant covers 115 sq. mi. or 54 per cent of the area of the entire city. The present population is 1,387,000 or 38 per cent of the total population. It is estimated that the 1950 population will be 1,769,000, and in 1960 it will serve about 2,000,000.

For the past ten years under a partially metered system the average daily per capita consumption has been 264 gal. With 100 per cent metering, the average per capita consumption will be greatly reduced, probably to well below 200 gal. per day. However, the area has possibilities for great industrial expansion and the industrial use of water may keep the average per capita consumption somewhat high.

Plant capacities

Plant capacity is based on a maximum average daily filtration rate of 2.5 gal. per sq. ft. per min. in winter and 3 gal. in summer. These rates are based upon the use of acid-treated sodium silicate in the treatment of the water to strengthen the coagulation during periods when the floc produced by the use of a simple coagulant only would not be strong. These rates may be exceeded for periods of several hours daily, with 3 gal. being a maximum winter rate and 4 gal. being a maximum summer rate. On account of the high friction loss through the sand beds at or above the 4-gal. rate, this rate should not be exceeded nor should an attempt be made to maintain it continuously throughout the day. Should a coagulant only be used the maximum winter rate should average not

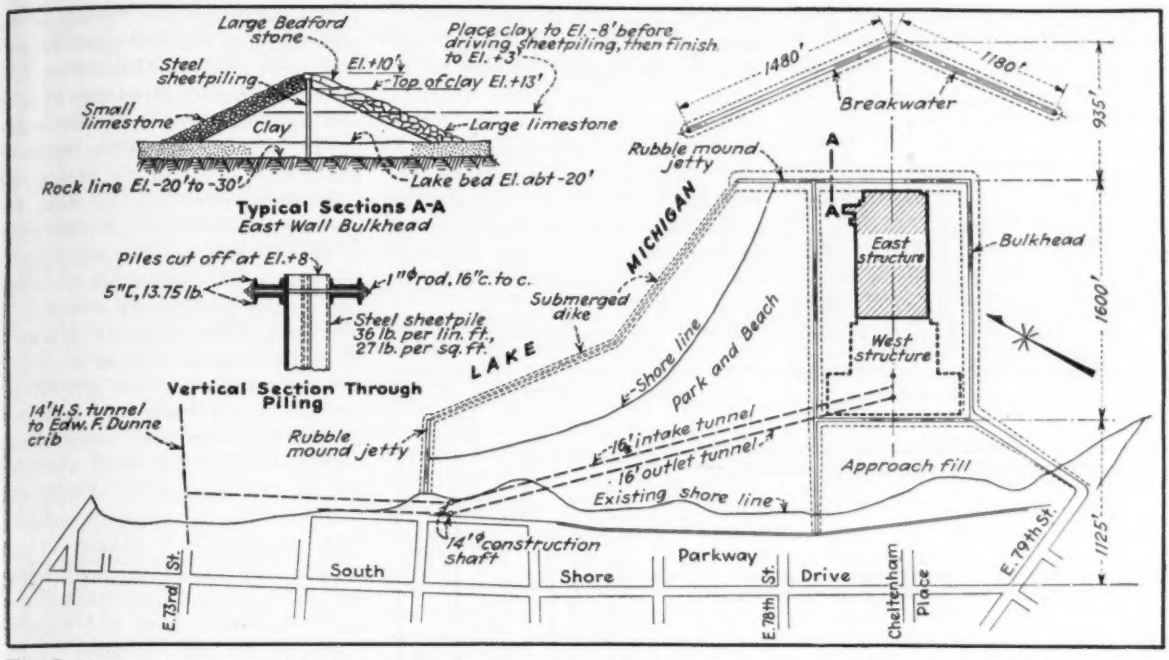

Fig. 2. Layout of the South District Filtration Plant for Chicago which is on a site that juts out from the lake front on made land. The fill is held in place by a bulkhead enclosing 38 acres.

more than 2 gal. for the day and should not exceed 2.5 gal. at any time.

The time of mixing after addition of the coagulant to the water, will be 45 min. for the 225-mgd yearly average of water treated. This will give 30 min. mixing time for the average of the maximum summer day and about 22 to 25 min. for the peak hour demand of the day, should it increase to the 4-gal. rate. The time of settling will be 4 hr. for the yearly average of water treated which time will be reduced to 2 hr. at the peak rate.

Breakwater and bulkhead

The breakwater is a rubble-mound structure 2,660 ft. long located in 22 ft. of water with the top extending 6.5 ft. above mean lake level. The underlying foundation is sand and clay with bedrock coming close to the bed of the lake for one-half the length of the breakwater. The bulkhead for the area containing the filtration plant consists of a clay corewall surfaced with riprap and topped off with large blocks of cut Bedford stone. A single line of interlocking steel sheetpiling driven through the center of this corewall to bedrock acts as a cutoff during the period in which it is used as a cofferdam. The area within the bulkhead (1,050x1,600 ft.) will be dewatered and the foundations for the filtration plant placed in the dry.

The park fill contract calls for the construction of two stone jetties, a submerged dike of stone construction, 1,440,000 cu. yd. of miscellaneous fill, and 560,000 cu. yd. of sand fill. The completed work will provide a wide sand beach extending from 75th to 78th St., with a waterline length of 3,300 ft. The miscellaneous fill is made up partly of clay and partly of granulated blast furnace slag. The upper sand fill will be 4 ft. in depth and will be built up of sand taken from the bed of Lake Michigan. At a later date part of this area on the land side will be covered with loam and landscaped.

The approach fill is to be the made land between the present shoreline and the west wall of the filtration plant bulkhead. It will consist of 190,000 cu. yd. of miscellaneous fill and 160,000 cu. yd. of sand fill. The latter to come from the lake.

Tunnels and substructures

Raw water will be taken from the present 14-ft. lake tunnel coming in from the Edward F. Dunne crib and will pass through a new 16-ft. intake tunnel to the filtration plant. After passing through the filtration plant the treated water will return through a new 16-ft. tunnel to the present tunnel system. The new inlet and outlet works consist of 10,200 lin. ft. of 16-ft. Chicago-section tunnel and a number of shafts and appurtenances.

The filtration plant substructure, divided into east and west portions, is to be constructed entirely of reinforced concrete. All earth within the plant limits will be excavated to rock in order that the nature and condition of this rock may be accurately determined before construction activities begin.

The east substructure, 850 ft. long by 480 ft. wide, contains the following basins listed in order as they occur from east to west: Intake basin, screen chamber, low-life pump room, raw water header basin, chemical mixing basin, flocculating basins and settling basins. In general the flocculation and sedimentation areas of the east substructure are divided into three similar basins each double-decked and separated from one another by galleries which house the machinery for the flocculators and scrapers. Some 110,000 cu. yd. of concrete and 11,000 tons of reinforcing steel will be required to build the structural portions of this east substructure. Bids on this unit of the project were received on Oct. 11, 1939.

The west substructure is 700 ft. long by 900 ft. wide, and will contain 80 filter beds grouped in units

of 20 each. It will also contain the 50-mg clear-water reservoir. Plans and specifications for this unit of the work are now under way and should be advertised some time this month.

Design features

The galleries, which are designed as rigid frame structures, and the retaining walls will be self-supporting and capable of resisting external earth pressures or internal water pressures. The structure is further designed to resist any hydrostatic uplift which might occur when the basins are emptied.

In connection with the drainage system, provisions are being made for pumping out all water which might seep into the space under the settling basins. An equalizer pipe connecting the space below the basins and the basins themselves is provided so that as the basins are emptied the pressure of the water on the outside is automatically relieved into the basin. A check valve is installed in this equalizer pipe to prevent water flowing from the basin to the space beneath. A cross-connection on the pump suction from the basins provides for draining the space beneath the basins simultaneously with the emptying of them, or separately if desired. Thus, any uplift due to outside water pressure may be eliminated from the sedimentation basins when they are empty.

All design assumptions, unit stresses and types of construction are in accordance with the provisions of the new Chicago building code wherever they apply. Because of the nature and purpose of the structure special attention was given to the concrete plans and specifications to assure water tightness, density and surface finish. About 0.4 per cent of temperature steel is provided in all of the heavy gallery and retaining walls which support heads of water up to 35 ft.

Due to the great size of the structure a comprehensive system of expansion joints was developed. In general, these joints are located on 160-ft. centers in both directions. Special care has been taken to prevent cracking in walls or slabs in the basins or galleries adjacent to the basins, not only to prevent leakage from the basins but also to prevent infiltration of groundwater or other contaminating waters. The prevention of cracking is also particularly essential in structures of this nature to safeguard the reinforcement against corrosion and the concrete against general deterioration. All basins are anchored to bedrock. Flat slab construction with tied columns is used wherever possible as this type of design was found to be the most economical. Panel sizes are 20 ft. square.

Four superstructures will house the offices, laboratories, chemical and mechanical equipment and supplies necessary for the operation of the plant. They will be steel, of skeleton construction with brick or stone walls and reinforced concrete floors. The roof construction will be precast concrete tile.

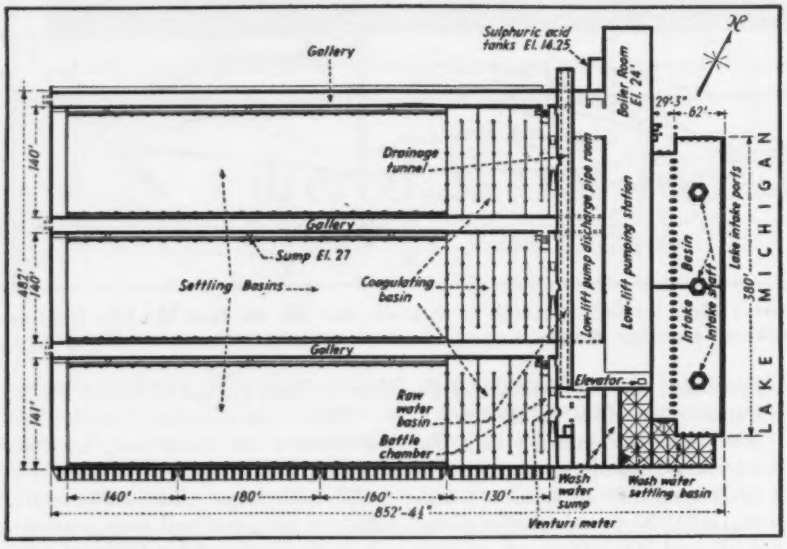

Fig. 3. East substructure which includes settling and coagulating basins, mixers, low-lift pumping station and the inshore intake basin.

Flow through plant

Raw water from the tunnels enters an intake well several feet below lake level by gravity and is screened before passing to a suction well at the

Fig. 4. Steel sheetpiling was driven into the clay core of the bulkhead to make it tight during the time it is being used as a cofferdam.

low-lift pumps. Four 50-mgd and four 100-mgd direct-connected motor-driven centrifugal pumps are provided to care for a peak load of 450 mgd. Each low-lift pump raises the raw water from El.—7 to El.+20 into a double-decked raw water conduit. This double-decked design permits either or both levels being used and permits cleaning without interruption to plant operation.

From the raw water conduit the water is metered to each of the three mixing chambers, flocculation and sedimentation basins. Any one of these units may be taken out of service for cleaning or repairs. Sedimentation tanks allow a 4-hr. retention period before filtration.

Sludge removal

The sedimentation tanks are 32½ ft. deep but have an intermediate settling floor at one-half their depths. Over these intermediate floors, as well as over the floors at the bottom of the basins, scrapers are provided to drag the sludge to one side where cross collectors convey it to sumps for continuous removal. This sludge runs by gravity to a tank where, after concentration, the water is laundered off and returned to the raw water intake, while the sludge itself is removed for further concentration and disposal. Thus, the treated water and its chemicals are reclaimed.

All filter washwater is returned by gravity to a sump where the sludge is settled out and the clear water decanted into the low-lift pump section well. The sludge is added to that collected from the sedimentation basin for further concentration and disposal.

At the end of each sedimentation tank a carbonization chamber is provided where CO_2 may be added. The treated water then passes through sluice gates to a settled water collector in the filter building. Four laterals branch off this collector and, running under the filter gallery floors, distribute to four units of 20 filters each. Each unit of 20 filters discharges into a separate clear well located below the filters. From this point the water is metered into a filtered water collector which discharges into a filtered water reservoir, so arranged and divided by sluice gates that either half or all of the reservoir may be used. From the reservoir the filtered water enters the underground tunnels which supply the pumping stations.

The 80 filter beds are to be 54 ft. long and 26 ft. wide with a surface area of 1,404 sq. ft. The top of the washwater troughs are to be set 24 in. above the tops of the sand or at an elevation so that no part of the trough will touch the sand when the filter is in service. The washwater gutter is to extend lengthwise of the filters so that the length of the washwater troughs is that of the width of the filter bed. Under ordinary conditions the water level is to be maintained 7.5 to 8.5 ft. above the top of the sand. Perforated pipe underdrains, 4 in. in diameter and spaced on 12-in. centers, will be shown on the plans but it is intended to allow bids on patented filter bottoms. A surface wash system will be provided.

Personnel

Design and construction of the South District Filtration Plant are being carried out by the bureau of engineering of the Department of Public Works, City of Chicago. Oscar E. Hewitt is commissioner of public works; Loran D. Gayton, city engineer; O. B. Carlisle, engineer of waterworks design, and James J. Versluis, engineer of waterworks construction. The PWA officials are as follows: D. R. Kennicott, regional director; Carroll Beale, project engineer; L. J. Ruddock, chief resident engineer inspector.

Contractors so far on the work include the following: Breakwater, a $709,825 contract, completed, Great Lakes Dredge & Dock Co., Chicago; bulkhead, a $1,167,250 contract, essentially completed, park fill, a $983,100 contract under way, and the approach fill, a $116,200 contract started in October, Fitz Simons & Connell Dredge & Dock Co., Chicago; tunnels, a $1,589,200 contract, started in August, Wenzel & Henock Co., Milwaukee.

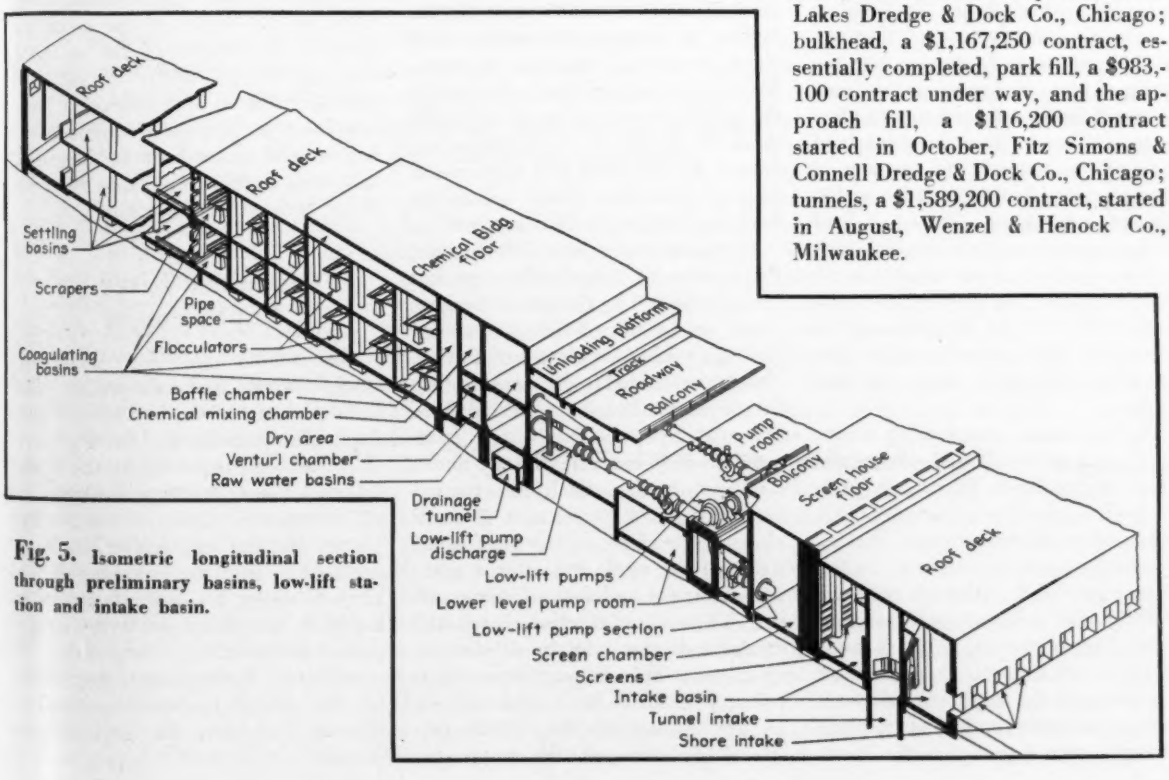

Fig. 5. Isometric longitudinal section through preliminary basins, low-lift station and intake basin.

Tests of Concrete Slabs For Bridge Floors

Contents in Brief—Three series of tests at the University of Illinois reveal factors that assure adequate strength in slabs subjected to concentrated loads. Heavy curbs that stiffen the edges of slabs decrease bending moments and permit shallower slabs.

STUDIES of reinforced concrete slabs subjected to concentrated loads, for the purpose of more effective design of slabs for highway bridge floors, have been carried out at the University of Illinois, in cooperation with the U. S. Bureau of Public Roads and the Illinois State Division of Highways, and these studies are reviewed in Bulletins 313, 314 and 315 of the university's engineering experiment station. Conclusions presented by Nathan M. Newmark and Henry A. Lepper, Jr., in Bulletin 313 may be summarized as follows:

The ordinary theory of flexure of slabs is adequate when the load is distributed over an area of diameter or width equal to or greater than the depth of slab. For more highly concentrated loads a special theory must be used. Tensile stresses under load are independent of the manner in which the load is distributed over the area of application. With the load in the central part of the slab, the type of support at the edges has no important effect on the stresses in the vicinity of the load. Much more important in this respect are the relative sizes of loaded area and slab thickness.

The maximum moments in a slab due to concentrated load do not decrease as rapidly as in a beam when the load approaches a support. This means that flexual stresses due to such load near a support may be important in a slab, although they are negligible in a beam. Overhang of a slab beyond the support has some effect on the stresses when the load is quite near the supported edge. It permits a redistribution of twisting moments, with a change in the distribution of reaction along the edge, and a decrease in the stress under the load.

Tests of long slabs supported on the long edges, and also of square slabs, as recorded in Bulletin 314 by Frank E. Richart and Ralph W. Kluge, form the basis for conclusions which are here condensed. The yield point stress of ½-in.-square deformed bars was 45,000 lb., and the average ultimate compressive strength of concrete about 3,900 lb. Modulus of elasticity as determined from flexural tests was close to 4,500,000 lb. Strains measured in the large rectangular slabs at low loads of 4,000 to 8,000 lb. compared well with computed strains. The loads required to produce initial cracks in these slabs varied from 8,500 to 13,000 lb. Such cracks were fine and short, difficult to detect on the ordinary concrete surface, and they closed up completely when the load was removed. Loads of 48,000 or 56,000 lb. applied at nine points on the large slabs produced general cracking. Measurements indicated stresses in the reinforcement as great as 42,000 lb. at the 48,000-lb. load. Failure occurred by punching out a truncated cone of concrete, except where the load was very close to a support.

In the tests of slabs 5 ft. square, the strains at low loads were not greatly affected by the size of bearing plate or by the bedding material (sponge rubber or plaster of Paris). The strains tended to decrease slightly for the larger bearing plates. Failure occurred by punching out a truncated cone of concrete directly under the loading disk. Such failures occurred at loads 50 per cent or more above the load producing yield point stress in the steel, and after a number of cracks had formed. Comparison of measured and computed strains indicates a fairly satisfactory agreement. This is important, since primary failure in a slab occurs usually through yielding of the tensile steel, although the tests also showed a fairly satisfactory margin of safety after the yield point in the reinforcement had been reached.

Bridge floor slabs up to 30-ft. span with stiffened edges and supported at the ends are the subject of studies recorded in Bulletin 315 by Vernon P. Jensen. Two factors having an important bearing on the moments developed are the ratio of the sides of the slab and the relative stiffness of the edge member. This stiffness is assumed as due to the curb alone, without considering the effect of the handrail. In a slab of 25-ft. span, with heavy curb, the moment under an outside wheel is 87 per cent of that under an inside wheel, and both moments increase as the curb is made smaller. Increasing the stiffness of curb increases the percentage of lateral moment. The required area of transverse steel is found to be somewhat higher than has been indicated previously, partly because the effect of the weight of the slab is included in the analysis.

From these studies it appears that the reduction in transverse moment in the slab does not differ greatly in percentage from the reduction in longitudinal bending moment in a beam as a moving load traverses the span. The amount of transverse steel at the quarter point should be not less than 75 per cent of that provided at the center of the span. In general, the results of the analysis indicate the possibility of using a slightly reduced slab thickness with a greater percentage of moment being carried transversely to the curbs and with a relatively large moment being resisted by the curbs.

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Calumet River Improvement

Government aid for widening, straightening and deepening the Little Calumet river, in Indiana, and for building levees for flood protection, has been requested by the Little Calumet River Drainage Association, of Hammond, Ind., as both the county and the state authorities have declined to help the financing of the project owing to lack of available funds. It is claimed the levees would permit reclamation of large areas of marshlands. Surveys are being made by CCC forces to determine the extent and estimate the cost of the project.

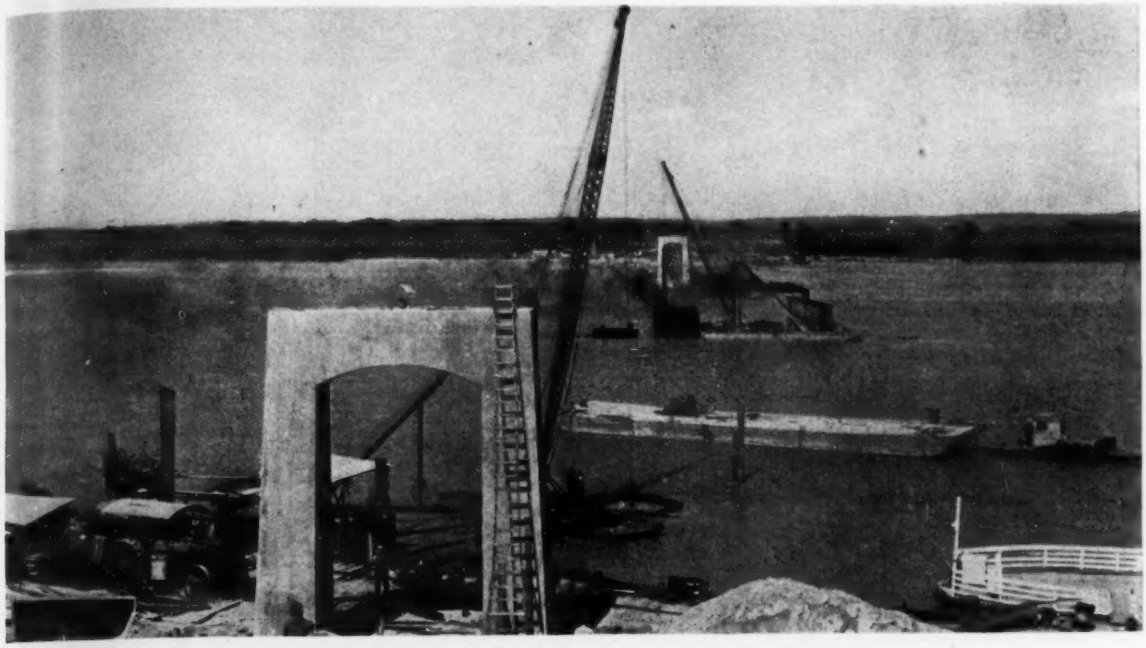


FIG. 1. BUILDING NEW TYPE PIER FOUNDATIONS FOR MISSOURI RIVER BRIDGE AT BROWNVILLE, NEB.

New Pier Design for Deep Overburden

E. E. HOWARD

Ash-Howard-Needles & Tammen, Kansas City, Mo.

Contents in Brief—Piers for the new Missouri River bridge at Brownville, Neb., consist of sheetpiles riveted to I-beams and driven in a circle to bedrock, with the enclosed sand plugged at the top with concrete. Twin cylinders for each pier are capped with a concrete slab as base for the pier shaft. Cost is 18 per cent less than pneumatic caissons.

A NEW PIER DESIGN aimed at avoiding costly pneumatic work where deep sand and gravel overlie hard material has been used in building the new Missouri River highway bridge at Brownville, Neb. Twin cylinders of sheetpiles, each pile having a steel bearing pile riveted to it, are driven to bedrock enclosing cores of the overburden. The material inside the cylinders is excavated to below the scour plane and the excavated material replaced with plugs of concrete. Over all, spanning and enclosing the tops of both cylinders, is a concrete cap from which the pier shafts are built up as illustrated.

The characteristic deep ground conditions of the Missouri River are a substantial bedrock of limestone or hard shale at depths from 60 to 75 ft. below low water. The river bed material is generally sand, increasing in coarseness with depth; thin gravel deposits are sometimes found near bedrock. Most bridge piers in the river have been built by the pneumatic process; the piers for the Brownville Bridge were devised in an effort to provide improved pier construction avoiding the expensive equipment and the labor costs involved in pneumatic construction.

The design for the new type of pier was developed early in 1937, the conception following recognition that steel piles could be driven for the conditions under consideration so as to have a complete and substantial bearing upon bedrock. Studies of the possibilities of using steel piles developed into the idea that the piles could be made to serve a double purpose by arranging them to function as bearing piles and also as the crib or cofferdam for the pier. Steel piles made up of an interlocking sheetpile with an attached I-beam could obviously be made of the section necessary to function as columns for the loads desired. The disposition of such piles at the perimeter of the pier base affords definite advantages, and a circular caisson maintained in form provides a complete foundation base.

Since the piles are designed as the supporting members there is no necessity to fill the caissons with concrete down to bedrock. To provide stability, however, the design contemplated excavation to about 5 ft. below maximum probable scour and concrete filling deposited under water to that depth. This concrete encases the I-beams of the steel piles projecting within the cylinder and provides complete rigidity of the cylinder. With a tightly enclosed cylinder it is obvious that the enclosed material below the concrete will re-

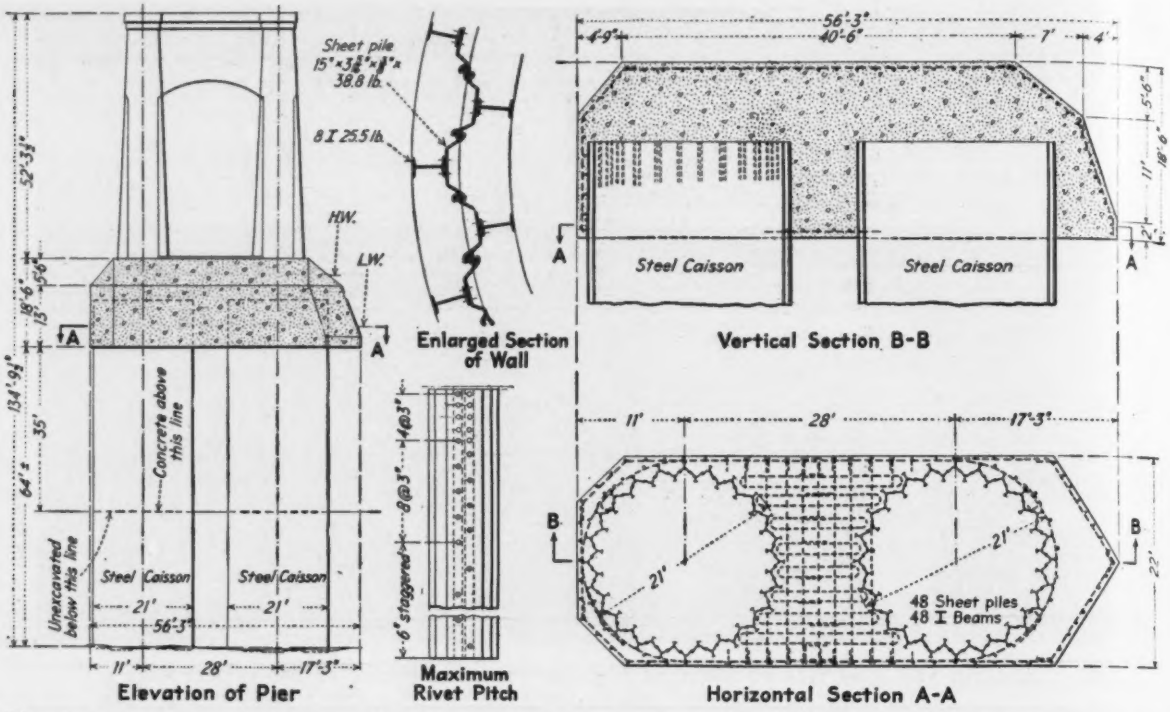


Fig. 2. Typical pier for the Brownville Bridge with details of the new foundation design for deep sand overlying rock.

main in place, and since here it is of sand and gravel it affords load capacity additional to the pile support.

Each pier as shown by Fig. 2, consists of two cylinders of steel piles driven to bedrock and filled with concrete to well below the maximum scour line. The two cylinders are joined by a concrete girder or coping supporting the upper pier shaft. No part of the steel piles is exposed above low water. Examination of some steel casings on very old piers in the Missouri River has disclosed little or no rusting, except over the areas between extreme low and ordinary water.

Construction is simple

Complete designs both for piers of usual type, to be sunk either pneumatically or by open dredging, and for the steel pile piers, were prepared, and bids on both types were received. The lowest bid for the three steel pile piers constituting the main river piers was about 18 per cent less than the lowest bid for the corresponding pneumatic piers. The facility with which the work has been executed evidently justifies the difference in bid costs.

As indicated in Fig. 1, the equipment required at Brownville was simple, consisting of derricks located on platforms for a shore pier, or on barges for a river pier, which handle all of the equipment for driving the piles, for excavating and for depositing concrete.

The preparatory work consisted of driving a column of timber piles that supported inside wooden templates around which the steel sheet bearing piles were assembled. The piles were provided in two lengths, with welded splices staggered in position in alternate piles. Both single-action and double-action steam hammers were used, but the latter was found to be most satisfactory. Jetting was used to some extent, and was found advantageous in expediting the driving. The piles were driven and jetted until they rested on bedrock, and each pile was then thoroughly tested for load capacity.

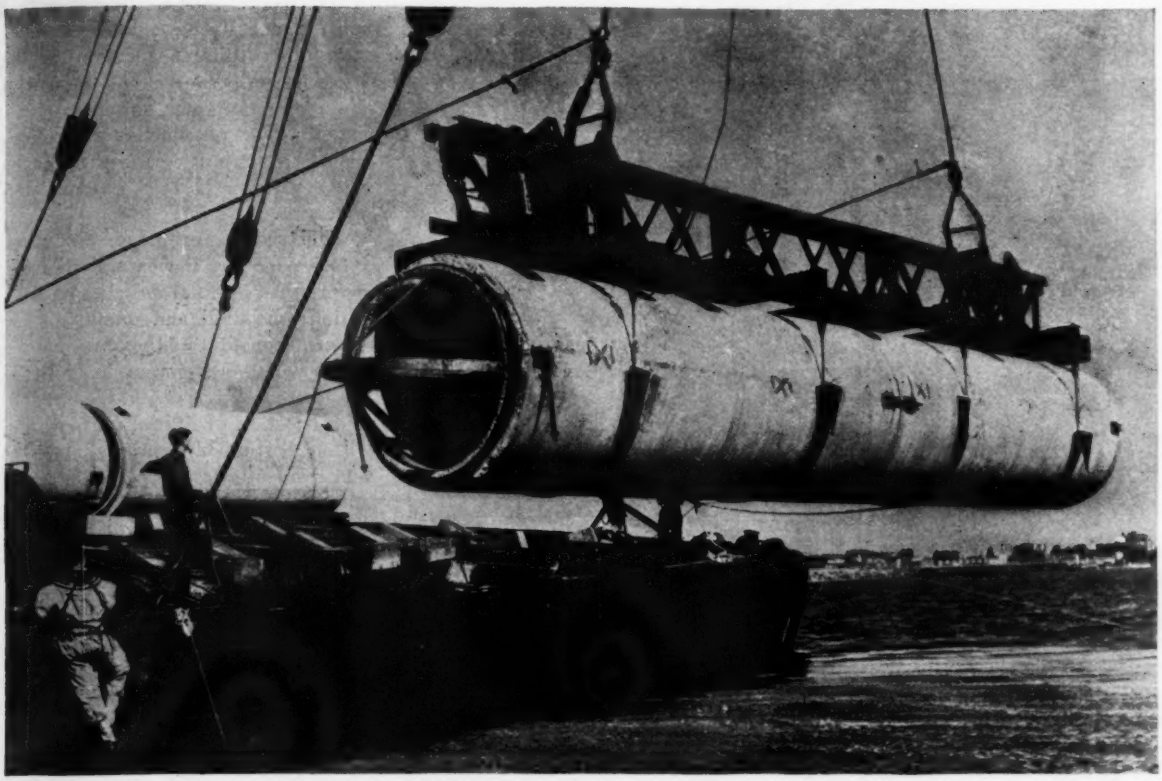
After driving, each cylinder was excavated with a bucket down to the depths required, and the concrete was deposited under water.

The bridge structure

The Brownville Bridge is a toll highway crossing being constructed by Atchison County, Mo. It was financed by a PWA grant and by toll-bridge revenue bonds issued by the county. This location is one of the oldest crossings of the Missouri River, and it is said that a ferry has been in operation continuously since before the Civil War. The town of Brownville was a thriving community before Omaha was founded, and was at one time the largest community in Nebraska. The bridge will serve the traffic on Highway 4 in Missouri, which is an east-west highway through the northern tier of counties in the state, and Highway 3 in Nebraska, which is correspondingly routed through the southern tier of counties in Nebraska. These highways constitute part of a short through route from Chicago to Denver.

The bridge consists of an 840-ft. two-span continuous through truss over the channel with I-beam approach spans, all on concrete piers. The bridge is 25½ ft. wide between handrails, with a two-lane highway composed of reinforced concrete floor slab 22½ ft. wide between curbs.

Design and construction supervision are by Ash-Howard-Needles & Tammen, consulting engineers, Kansas City, Mo. C. F. Lytle Co., Sioux City, Iowa, is substructure contractor and the superstructure was fabricated and is being erected by the Bethlehem Steel Co. Ray O. Richards represents the owner, E. A. Lotz is resident engineer inspector for PWA and H. J. Bernat resident engineer for the consultants.



LAYING THE 72-IN. CONCRETE PIPE OUTFALL FOR THE CONEY ISLAND, N. Y., SEWAGE TREATMENT PLANT

The City's Sewage Goes to Sea—I

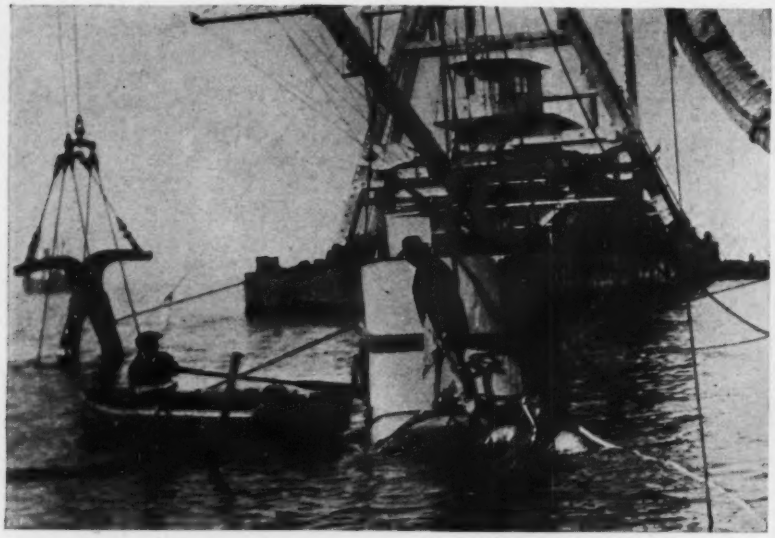
N. A. BOWERS
Pacific Coast Editor, Engineering News-Record

Contents in Brief—Experience with subaqueous outfall sewers in recent years provides valuable data on their design, construction and maintenance. This article, the first of three installments summarizing information from all parts of the country, deals with the function and types of installations. Succeeding articles are devoted to the design and construction, and to operation and maintenance.

A SUBAQUEOUS OUTFALL SEWER to meet stated requirements, no matter how commonplace the conditions may be, must be regarded as a special design job; no such thing as "standard design" is recognized. Each installation is planned largely on the basis of the designer's experience and judgment supplemented by information that is to be had on similar outfall projects. A considerable number of subaqueous outfall sewers have been built in recent years and thus important chapters have been added to the none-too-complete data available as a guide in making decisions on design and construction.

Since outfall sewer projects have been carried out in widely separated locations and, more particularly, as maintenance problems have been solved and failures have occurred here and there, there has arisen both the need and the opportunity for assembling data and records of experience. Some of the most difficult jobs and much of the new information has to do with outfalls into the ocean. In the following, the experience on many projects in different parts of the country is summarized and particular attention is given to information on operation, maintenance and failures.

A subaqueous outfall sewer may be in several forms other than pipe. The White's Point sewer in California, for instance, passes through a 2-mile tunnel just before reaching the shore and as the tunnel is entirely below sea level it might properly be said to be the tunnel portion of the outfall. New Jersey's Passaic Valley outfall was built in tunnel to an offshore caisson whence pipe construction continues. There has also been some monolithic construction within cofferdams particularly in inland or sheltered waters. Combinations of these and other types have been selected as the most economical under various conditions.



Lowering an elbow for a large concrete sewer outfall. Final inspection on the surface has been made and at this stage a marine diver takes over direction of placement.

In the following, however, attention is given exclusively to outfall sewers built of pipe. Designers strongly favor pipe for ocean outfalls, particularly beyond the surf line because of the relatively safe construction methods involved: pipe-laying equipment can seek harbor when storms come up, thus leaving at the site no temporary structure exposed to wind and wave.

Function and type

Where large cities are adjacent to salt water in which tidal currents are brisk, and where beaches are little used for recreational purposes, ocean disposal of sewage frequently has been successful at low cost. If the sewage contains industrial wastes there is added advantage to ocean disposal —such wastes sometimes seriously complicate and add to the cost of treatment processes.

Sanitation requirements may make screening or sedimentation a prerequisite even for outfalls that extend several thousand feet into the ocean. In the matter of necessary length, from the sanitary viewpoint, the California State Board of Health has made a significant observation, as follows:

> Studies by the California Bureau of Sanitary Engineering on the extent of sleek fields surrounding sewer outlets off the California coast (in locations where the depth of water and distance from shore permitted free dispersion of the sewage) led to the conclusion that the area of sleek fields bears a relationship to tributary population which can be expressed as follows:

Tributary Population	Sleek field in acres per 1,000 pop.
1,000,000	1.0
100,000	4.5
50,000	5.5
25,000	6.0
10,000	8.0

> The Bureau, therefore, uses this relationship in deciding upon the length of ocean outfalls necessary to keep the beaches free of sleek menace or undue bacterial contamination.

Requirements ordinarily set up as fundamental in the outfall design problem are: (1) provision for conveying a stipulated quantity of sewage flow to a point of discharge far enough from the shore line, under the conditions existing at the site, to prevent nuisances that will be condemned by health authorities; (2) a type of construction that will give the sewer:

(a) long life

(b) low operating and maintenance costs and

(c) possibility of extensions such as may logically be expected later.

Choice of location

Within the limits fixed by economical gravity delivery there has been a fairly wide range in choice of possible locations for an outfall sewer. First considerations usually are limitations imposed by a state board of health or some other agency responsible for sanitation safeguards. Meeting sanitary requirements has so greatly increased the cost in some cases as to make the building of the outfall uneconomical. In inland fresh water channels, the consideration that most frequently has influenced selection of a suitable location is the proximity of sources of industrial and domestic water supplies, either extant or of possible later development. In harbors, permits must be obtained from the U. S. Engineer Department.

Construction problems are taken into account by the careful designer before making final decision on a location: the kind and quality of the material constituting the ocean bottom and the bottom topography must be considered. Water depth, the strength and direction of littoral currents and distance from recreational beaches and residential areas are likewise the subject of much study.

The risk of damage to the sewer from dragging anchors has been emphasized by trouble of that sort. This risk is not wholly absent even in outfalls laid in the open ocean. Witness the fact that when the Santa Ana County (Calif.) outfall, a 42-in. cast iron pipe, was damaged by seagoing craft twice within a year, repair costs totaled $70,000. There may be no legal recourse after such accidents but insurance against them is to be had, the outfall just mentioned is now protected by a $100,000 insurance policy.

Risk of pipe movement

In analyzing foundation conditions that bear on location, the custom has been to give particular attention to the zone in which the waves break. Major risk of movement, both that resulting from wave action and that arising from bottom scour, designers hold, is greatest in this zone. Here, too, because maximum changes in pressure-head occur where the waves tend to peak, the water-hammer effect of waves is greatest and there is danger of sand forcing its way into the line through joints. Comparatively little shifting of the bottom occurs farther out in deeper water. Some authorities put 35 ft. as the depth beyond which bottom conditions may be expected to be fairly stable except where the littoral currents are strong.

Because of seasonal variations at many beaches, records of currents are regarded as valuable only if they extend over more than a year. Currents are an asset in dispersion but if the bottom is soft their possible adverse effect on the foundation is

given careful attention. Surprisingly little current along the bottom in deep water has been reported at some beaches where surface conditions are generally rough. From the breaker line shoreward, however, heavy wave action is regarded as closely related to shifting bottom.

Outfall types

For relatively small sewage flows the advantage of all-metal pipe is generally accepted without question. This naturally follows from the fact that installation of metal lines of small diameter have been quite successful. Where iron pipe sections connected with threaded couplings are used, or where the pipe is a continuous-welded line, it is feasible to plan outfall construction methods on a basis quite different from that used where pipe diameters of more than 18 in. are required. This is indicated by the custom of giving consideration to outfall sewer problems as though outfalls were divided into two classes on a pipe-diameter basis, i.e., with the line of demarcation at a diameter of about 18 in. Where the required outfall capacity is only two or three times that of the maximum diameter for all-metal pipes using threaded joints, an expedient sometimes used is a multiple line of all-metal pipe.

Oil pipeline experience

Although submarine pipe lines laid for conveying oil differ in many respects from subaqueous outfall sewers, yet design and construction of small diameter outfalls have been improved materially by borrowing from experience of the oil companies. Four oil companies operate submarine lines on the West Coast for loading tankers anchored offshore at points where docking facilities are lacking. These lines, none more than 18 in. in diameter, usually terminate in a 12-in. rubber hose whose outer end is left attached to a marker buoy when not in use. Sixteen such pipe lines now operated by one oil company are listed in Table I. Several of these installations are paralleled by "return lines," sometimes of smaller diameter, primarily used for washing the main line.

Commenting on practice in laying submarine oil pipes, H. H. Hall, chief engineer, Standard Oil Company of California, says, "These lines are made of the same steel pipe usually used for oil pipes in land service except that special requirements determine the weight (metal thickness) of the submarine pipe. Such lines should be too heavy to float but not so heavy as to drag badly on the bottom while the line is being pulled into place.

TABLE I—SUBMARINE OIL PIPES LAID BY STANDARD OIL CO.

Location	Line	Length (ft.)	Outside dia. and wall thickness (in.)
Estero Bay, California	No. 1	3,014	16 x 5/16
	No. 1 Return		12-3/4 x 476
	No. 2	3,476	18 x 5/16
	No. 2 Return		12-3/4 x 476
El Segundo, California	No. 1	3,200	16 x 5/16
	No. 1 Return		6-5/8 x 322
	No. 2	3,660	13-3/4 x 48
	No. Return		13-3/4 x 48
Mazatlan, Mexico	Single Line	4,700	12-3/4 x 1/2
Bahrein Island, Persian Gulf	No. 1	11,000	12-3/4 x 5/16
	No. 2	11,000	12-3/4 x 5/16
	No. 3	11,000	12-3/4 x 5/16
	No. 4	11,000	10-3/4 x 45
	No. 5	11,000	8-5/8 x 5/16
	No. 6	11,000	8-5/8 x 5/16

"Most of our present marine lines were laid without covering for protection against corrosion: not because corrosion can be neglected but because of the difficulty of securing a protective coating that will remain intact while the line is being dragged into place. Protective coatings are used, however, where submarine pipes are placed by lowering directly to final position. Some lines are protected from abrasion in the section through the surf by using two pipe thicknesses. That is, the oil pipe is enclosed within an outer casing, about four inches larger, and the annular space between is filled with asphalt."

Large-diameter pipe

For outfall diameters of 20 in. or more cast iron and concrete have been the materials ordinarily used. For diameters exceeding the top limit in cast iron pipe, reinforced concrete has been without competition (until the advent of the White's Point outfall) and outfalls of very large concrete pipe are not unusual. In a tabulation to be given in the final installment cost figures are given on concrete outfalls up to 96 in. in diameter.

Concrete is generally accepted as a satisfactory material for the pipe barrel itself in these large-diameter sewers. In the Hyperion outfall, which has given Los Angeles much trouble by reason of joint failure (attempted repairs described in *ENR*, April 7, 1926, p. 566) no part of the difficulty is attributed to the concrete as used in the pipe sections themselves. That material is still in excellent condition and is believed to have undergone no deterioration since its construction in 1925. An advantage frequently cited for reinforced concrete pipe is that it can be manufactured close to the site, thus reducing transportation costs and decreasing risks of delayed deliveries.

Copper-bearing steel pipe of relatively small diameter has been used to some extent in competition with the other metal pipes. However, long-term results on lines of this composition remain to be accumulated. Heavy cast iron pipe with bell-and-spigot joints has been used extensively and on the count of durability is commonly rated as wholly adequate. The rigid construction of the bell-and-spigot joint does not give the flexibility necessary under certain conditions of current and foundation.

In an article to follow, design and construction features of outfall sewers will be discussed. The third article of the series will describe operation and maintenance methods and costs.

. . .

Soft-Water Sludge And Sewage Disposal

Operation of the sewage treatment works at Hinsdale, Ill., have a problem in the handling of sludge from the lime-soda water-softening plant of the city waterworks. As reported in *The Digester*, bulletin of the State Department of Public Health, the following conclusions were presented by E. Greek, superintendent of the sewage works: (1) Lime sludge should be released to the sewer at a low rate of discharge; (2) when concentration of lime in sewage was about 350 ppm, the efficiency of removal of suspended matter in the Imhoff tanks increased from 64 per cent to 82 per cent; (3) lime sludge increases the pH of sewage, which is beneficial in freshening the sewage and retarding odor production; (4) about twice as much digestion volume is required in Imhoff tanks when lime sludge is to be taken as is needed for domestic sewage only; (5) although lime content allows sludge to be drawn in a less digested condition, the solids concentration may reach 25 per cent, causing difficulty in obtaining flow through piping. Digested sludge containing spent lime is also more difficult to dry, requiring about four weeks as a minimum.

FIG. 1. CROSS BRACING WAS ELIMINATED IN EXCAVATING FOR THE NEW ENGLAND MUTUAL LIFE BUILDING IN BOSTON.

Building on Soft Clay

Contents in Brief—To prevent unequal settlement, a large office building in Boston's Back Bay District, former tidal marsh, was so planned as to balance its weight against the weight of the excavated soil and distribute it by a concrete box substructure. This substructure is being built by an ingenious method, in which shores butting against sections of foundation slab hold the sides of the excavation.

SOFT CLAY SUBSOIL presented a major problem in planning the new office building of the New England Mutual Life Insurance Co. in Boston's Back Bay district, which is on the site of a tidal marsh reclaimed years ago by covering with 20 ft. of fill. Differential settlement was likely to be destructive, because of the large area of the building, 200x340 ft. Full study of the problem led to an unusual solution: The basement depth was made such as to give approximate balance between building weight and weight of excavated soil, so as to prevent subsoil compression of any magnitude, and the basement walls and floor were developed into a strong reinforced concrete box to distribute the building load and safeguard against local settlement. In constructing this foundation an ingenious arrangement and sequence of operations is being used to hold the sides of the excavation against movement without the cost and uncertainty of cross-lot bracing.

Foundation conditions

The site is bordered by Boylston, Newbury and Clarendon streets in the heart of the Back Bay area of Boston. Ground surface is 18 ft. above sea level, while rock is more than 150 ft. down and is overlain by 30 ft. of hardpan and 70 ft. or more of glacial clay. On the clay lies a 20-ft. layer of alluvial silt extending up to mean tide level and carrying the 20-ft. man-made fill. The top of the clay, 40 ft. below ground, is oxidized and hardened to a firm yellow clay for a thickness of 8 to 10 ft., which has good bearing power and from experience with other buildings is known to be an effective distributing layer for moderate loads; the unoxidized clay below, however, is soft.

Settlement by consolidation of the glacial clay has been observed in a number of buildings adjoining the Charles River basin, where the same subsoil condition prevails, and buildings of large horizontal dimensions have in several cases settled unequally. The foundation problem therefore was given thorough study by Cram & Ferguson, the architects. They retained Prof. A. Casagrande, of Harvard University as consultant. After making laboratory tests of the subsoil he confirmed the apprehension that the weight of the build-

ing, about 130,000 tons, might produce a substantial amount of consolidation of the soft clay and in time probably unequal settlement, with risk of damage.

Additional difficulty arose from the desire to provide for increasing the height of the wings of the building at a later time. The original construction contemplated (Fig. 2) embraces a one-story front wing, four-story side wings, and a ten-story rear wing, but according to the plans developed by the architects the side and front wings may later be raised to 10-story height, adding about ½ ton per square foot to the foundation load here.

Foundation plans changed

Early plans for the building contemplated a single basement, and column and wall foundations of piles or piers going through the silt to the hard layer of clay. The average increase of load on the clay over the whole building area would have been about 1 ton per square foot, which in view of the test results was concluded to be excessive and likely to cause consolidation of the soft material below. Re-study of the design showed that addition of a sub-basement, carrying the excavation through the silt to the hard clay and placing spread footings on the clay, would remove enough soil to eliminate this excess loading. It also would save the cost of piles or caissons, and in addition would provide a sub-basement garage. The spread footing plan was adopted.

Effective distribution of the load over the whole area of the building was believed essential to the success of the load-balancing plan. Accordingly, the design was so worked out as to impose all the building load on continuous wide footings of the substructure walls. To assure this distribution in spite of possible variations in the consistency of the subsoil, the basement walls and floor were reinforced and tied together to form a strong reinforced-concrete box over the whole area of the building.

Hydrostatic pressure had to be considered in the design of the substructure. Groundwater level is about 10 ft. below the surface, and the head on the sub-basement floor thus will be about 30 ft. Subdrainage was not considered, in view of the possible injury that over a long period of time lowered groundwater level might do to foundations of other buildings. The floor was therefore designed to resist the uplift.

Design features

Thus the building comprises an integral box substructure 40 ft. high, with four longitudinal and six cross-walls of 3½-ft. minimum thickness, each wall resting on a full-length footing slab 15 to 18 ft. wide by 8 to 10 ft. thick. The building columns are carried on steel billets at the top of these walls, and the floor framing spans between wall members. Typical sketches of the substructure are shown by Fig. 3. The foundation is so proportioned that in both original and future condition the building weight will be about equal to the weight of the soil removed, with not more than ¼ ton per square foot excess or deficiency. The average pressure under the wall footings is about 4 tons per square foot without taking account of buoyancy, or 3 tons after deducting water uplift.

The substructure walls are reinforced as girders, and the outer walls also as retaining walls for both vertical and horizontal transfer of earth pressure to footings and cross-walls respectively. The footings of the outer walls also contain, in addition to reinforcement as cantilevers from the wall, horizontal steel along the inner face so that they can function as horizontal girders delivering the earth thrust to the cross-walls, through struts below the slabs in some cases.

Open areas between the wall footings are floored with slabs from 3 to 7 ft. thick placed integral with the footings. Where minor interior columns rest on the thinner slabs, reinforced beams are constructed beneath.

A central tower 280 ft. high in the middle of the interior court of the building, planned both as an architectural feature and as elevator and tank tower, is supported by a continuous 5½-ft. reinforced slab under its entire area and the adjacent court areas. The elevator shaft columns rest directly on this slab, while the substructure walls under the tower are part of the general box foundation.

The superstructure of the building includes floor framing spanning the full width between outer walls of each wing; reinforced-concrete floors; suspended ceilings; and brick exterior walls faced with stone. The windows, in order to make daylighting most effective, are casements carried up above the net ceiling height to penetrate the suspended ceiling, which is recessed at the windows to give increased lighting angle.

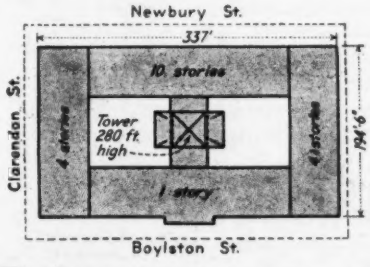


Fig. 2. Large ground plan and unequal distribution of superstructure weight complicated the foundation problem.

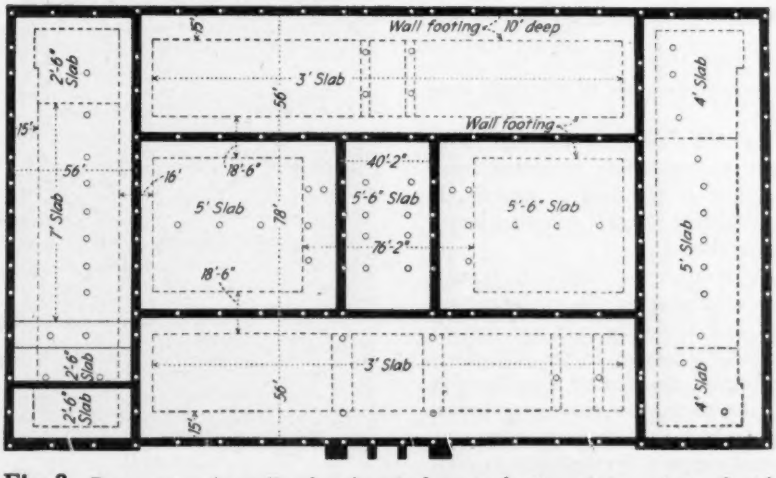


Fig. 3. By carrying the walls of each unit down to footings that are integral with the sub-basement floor slab a strong box of reinforced concrete is produced to distribute the weight of the building over the foundation area.

Floors are designed for 125 lb. live load up to the fourth floor and lower loads above, depending upon occupancy, to a minimum of 60 lb. on the lightest floors. In addition, provision is made for 25 to 30 lb. of partition load throughout, since the requirements of the insurance offices as well as of tenant spaces require freedom to place and shift partitions without restriction.

Unusual floor framing results from this structural arrangement. The typical main floor supports are 36-in. wide-flange girders 56 ft. long, spaced 18½ ft. apart and carrying two cross-beams. The square panels formed by beams and girders are filled with a pan-type floor of stone concrete. The main girders are fireproofed with gypsum blocks, and a suspended ceiling is hung below the girders. Telephone and other communication conduits are embedded in the concrete floor slab, which makes a fill layer over the slab unnecessary. Light conduits pass through the space between the floor and ceiling. Air-conditioning and heat ducts pass through the 36-in. girders, as do some of the main conduits.

The roof slab is covered with membrane waterproofing protected by a pavement of tile laid in asphalt. It was designed to carry planting boxes for shrubbery.

To reduce the risk of ground movement during the substructure work and avoid the cost and hazard of cross-lot bracing in the 40-ft.-deep excavation, the Turner Construction Co., contractor for the entire building, devised an ingenious system of ground support, worked out in conjunction with the architects and consultants. It takes advantage of the fact that the building walls are set back 20 ft. from the street line, so that the upper half of the excavation could be kept on a natural slope and a supported vertical face would be required for only the lower half.

Groundwater drainage was important. A test pit sunk to subgrade showed that the sand and gravel fill drained freely while the silt was practically impervious and drained slowly. Since vertical side faces would have to be maintained in the silt, the preliminary drainage of the overlying pervious stratum was essential to economy and safety of the work.

Under the system devised for the purpose, the sand and gravel was first excavated, down to the top of the silt, with sides sloping back as natural banks to the street line. At the foot of this slope a clay-lined wooden drainage gutter was built, to intercept groundwater draining from the sand and thus keep it from softening up the silt below. Just inside this gutter a series of 12-in. H-sections was driven to a depth of about 10 ft. below subgrade at 8-ft. spacing, to form the main members of the cofferdam of the subsequent silt excavation.

From the top of the slope inside the line of H-sections the silt was excavated dry to the underside of the slabs in the central part of the lot. The sides were sloped and trimmed to 40 deg. Excavation under the interior wall footings was carried down to the hard clay, the sides of the trenches standing vertically without sheeting. A square mat of concrete was poured with the outer sides 25 to 30 ft. distant from the future cofferdam or finished outer wall line. The average section poured contained about 100 tons of reinforcing steel and 1,200 cu.yd. of concrete.

Steel raking struts were next set from this concrete block to the cofferdam posts and wedged tight against the posts 5 or 6 ft. below the top of the silt slope. With the posts thus shored, excavation of the silt slope to a vertical face began, horizontal lagging being placed back of the flanges of the H-beams as excavation proceeded. When subgrade was approached, horizontal steel struts were placed between the footing block and the cofferdam posts just below subgrade level, holding each post firmly at two points against the concrete.

On completion of side-wall excavation in the section adjoining the footing block, the wall footing and adjoining slab back to the previously placed foundation block were concreted, and immediately on their completion the inner forms for the outer wall were erected and the cor-

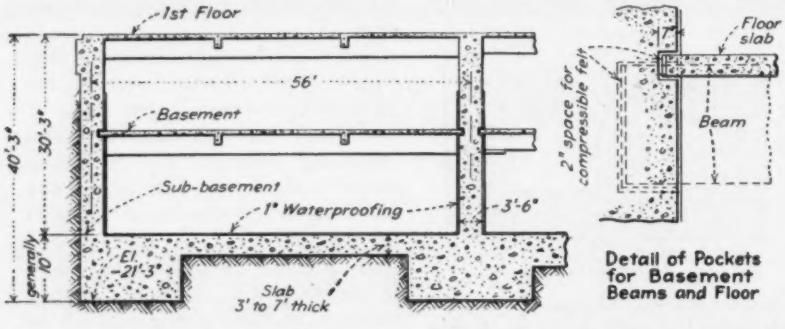


Fig. 4. In vertical section the concrete box substructure of the building consists of walls 40 ft. high resting on continuous wide footings; floor slabs integral with the wall footings complete the base of the substructure.

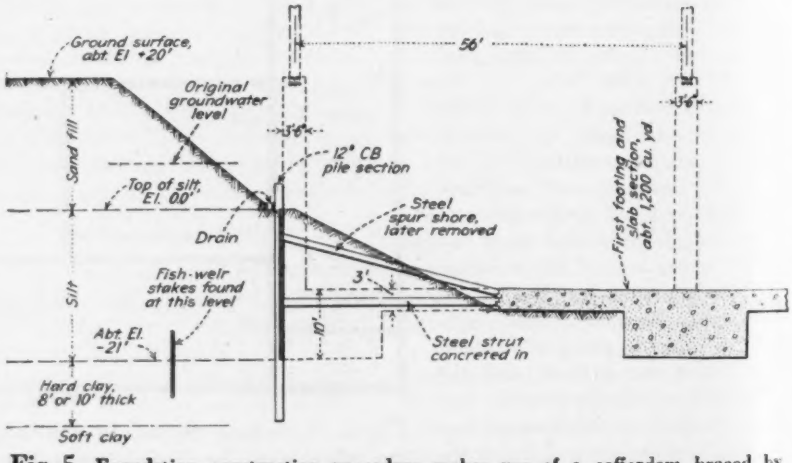


Fig. 5. Foundation construction procedure makes use of a cofferdam braced by struts footing against previously poured interior sections of foundation slab.

responding sections of wall poured. Conditions just before pouring the wall are shown in the view Fig. 1.

While side-wall excavation and concreting was proceeding in this way, at one corner of the lot, other areas of subgrade were cleared and further sections of wall footings and slab poured, in single or multiple panel units as the progress of excavation permitted. With the completion of additional blocks along the foot of the bank, further sections of side wall were excavated and concreted by repetition of the procedure described. All concrete was readymixed material delivered by truck at street level and chuted down the slope into position. This concrete was 1:2:4 mix developing a crushing strength of 2,800 lb. at 28 days.

The upper surface of the entire foundation slab and the inner face of the exterior walls are to have plaster-coat waterproofing applied.

The footing of the outer wall, which with the wall itself forms an L-shaped retaining wall, is so proportioned that the active earth pressure of the surrounding soil brings the resulting load to the middle of the footing width. The footing also is reinforced as a horizontal girder to take the inward earth pressure and deliver it to the cross-walls of the building.

As the outer wall will deflect inward slightly while carrying the earth thrust by horizontal-girder action, provision is made to prevent transfer of this thrust to the steel framing of the basement floor. For this purpose the basement beams that enter the retaining wall are supported on expansion plates, and a pocket is formed in the wall concrete around their ends to give room for free movement between steel and wall. The first-floor girders, on the other hand, will not be set in place until the wall has been backfilled and the fill thoroughly compacted by tamping and puddling, in order to develop full loading and deflection of the wall and assure that the steel when placed will be permanently unstrained.

Quantities of material in the substructure are: 100,000 cu.yd. of excavation, 25,000 cu.yd. of concrete, 1,500 tons of reinforcing steel. The cofferdam posts, lagging and bottom struts are left in place, while the steel raking upper struts are concreted in the outer walls and subsequently burned off several inches back of the wall line and removed.

Fig. 6. Drawing of the New England Mutual Life Insurance Co. building.

Clearing the site began on May 1, 1939, with demolition of old buildings, and excavation will be completed about Dec. 1. About one-half of the footing and floor slab concrete is in place and preparations for concreting the wall sections throughout the lot are actively in progress. The contractor's schedule calls for completion of the substructure by Feb. 1, 1940.

The site of the New England Mutual Life Building is historically interesting in part because it was occupied by two old buildings of Massachusetts Institute of Technology, the oldest of which, the Rogers Building, was erected about 70 years ago. This building, as well as a companion building at the west end of the site, was founded on piles driven to the hard clay. Both buildings continued in use by the institute and later by Boston University until a year ago.

Fig. 7. Part of prehistoric fish weir in the top of the clay, 20 ft. below tide level, as revealed by a vertical cut along the wall of the weir.

Much greater historical interest attaches to the discovery of a well-preserved fish weir in the top of the clay, 20 ft. below tide level. It was found in the southerly part of the site, adjoining Boylston St., when excavation approached subgrade. The weir consisted of close-set vertical withes or thin poles apparently driven into the top of the hard clay and projecting several feet up into the overlying silt, with brush crowded in horizontally. Old oyster shells surrounded some of the vertical poles for several feet below the top of the clay.

In 1913, when the Boylston St. subway was constructed along the south side of the site, parts of this fish weir were encountered, subway floor being about at the same elevation as the foundation of the new building. As this fish weir probably was built before the silt layer had begun to deposit and when the clay surface now 20 ft. below tide was at or near the tide level, archaeologists have estimated that the fish weir is several thousand years old and the oldest evidence of human handiwork in the region.

Superhighways and Subways for Chicago

Contents in Brief—Two comprehensive reports on Chicago transportation have just been published; one relates to superhighways and the other to subways. Both plans are dovetailed into existing facilities within the city limits and outside. Work is under way on the subways and financing to start the superhighway has been authorized by the state legislature. This article outlines the plans and construction programs and gives the major cost estimates.

COMPREHENSIVE PLANS for a $205,000,000 system of superhighways and a $267,000,000 system of rapid transit lines for Chicago were made public Oct. 30 by Philip Harrington, commissioner of subways and traction and acting commissioner of superhighways. Of metropolitan telephone book size, the reports are comprehensive and cover all forms of traffic facilities within the city and connections to districts beyond the city limits. Figs. 1 and 2 indicate the pattern of the systems proposed. The former covers the immediate 32.3 mi., $110,000,000 program and future extensions for the balance of the 62-mi. layout. Fig. 2 pictures the day when 93 per cent of the population and 78 per cent of the area of the city will be within one mile of rapid transit facilities; subway, elevated or suburban railroads. An insert on the latter indicates the ultimate subway development in the central business district.

Recognizing the trend toward riding on rubber, the superhighway program looks forward to opening up the central portion of the city via five wide radiating trafficways. One of these main routes is Congress St., an east-and-west axis street laid out by D. H. Burnham in the horse-and-buggy days of 1908 and held to as a logical western outlet by most planners since that time. The PWA grant for subways requires submission by the city of a plan for opening Congress St., and it is this requirement which has brought both reports into focus at this time.

Superhighways

The paramount test utilized in selecting the superhighway plan, according to Mr. Harrington, is its adaptability to the promotion of general city development. Segregation of fast from slow moving traffic offers the only hope of disentangling traffic and providing facility and safety of movement for all.

The master plan proposed consists of five superhighways radiating from the four corners of a modified quadrangle around the central business district. The radials eventually are to be articulated by a crosstown artery providing for heavy north and south traffic 2 to 3 mi. west of the central business district. The express roadways are to be eight lanes wide centered in broad rights-of-way, aiming to benefit rather than depreciate property.

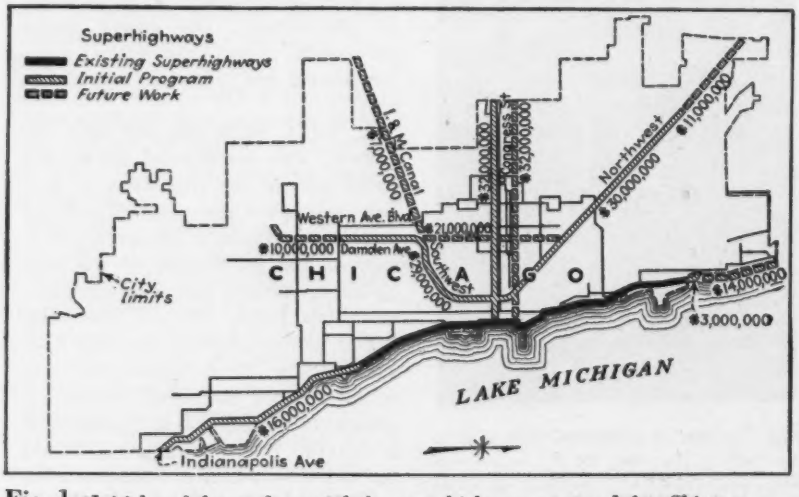


Fig. 1. Initial and future layout of the superhighways proposed for Chicago.

Noted on Fig. 1 are the estimates for the various routings. The mileages are as follows: North, 0.7; Northwest, 9.3; West, 7.7; Southwest, 7.3 and Southeast, 7.5 mi. The Northwest highway is now under study by the county highway department.

The city has concluded to take Congress St. for the West route, elevating it from Wells St. to Throop St. and depressing it to the west. East of Wells it is to be a surface street. The companion subway extension report contains details of the Congress St. route with its elaborate distribution plaza east of the river crossing.

The Southwest route follows Franklin St. south to Cermak Rd. thence southward and south to Garfield Blvd. The bed of the abandoned Illinois & Michigan Canal is recommended for use for an extension as soon as the canal is filled.

The Southeast highway extends the Outer Drive south and east to a connection with Indianapolis Ave. near the Indiana state line.

The specification recommended for these superhighways requires the following: Location and design to coordinate with interregional plan. Terminals to be adequate. Continuous separation from cross traffic. Separation of through roadways from abutting property. Limited access to express roadways. Separation of opposing streams of traffic. Ample widths of lanes. Adequate ramps. Adequate terminal facilities. Elimination of pedestrians and parking. No traffic control lights. Minimum as well as maximum speeds. Depressed "park-

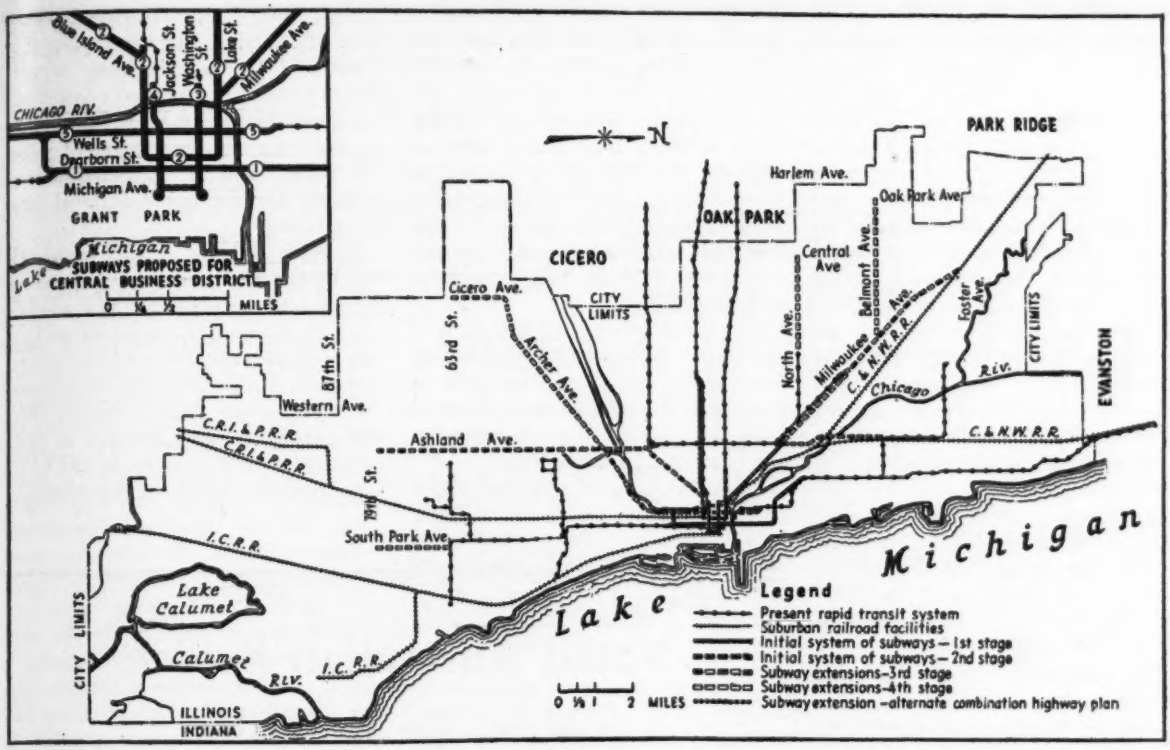


Fig. 2. Pattern of existing and proposed rapid transit facilities in Chicago. Details for the Loop district given in the insert. Numbers on the insert indicate the order of construction.

way type" where feasible and economical, to provide greatest benefit to surrounding areas.

The combined capacity of the five initial superhighways will be 30,000 vehicles per hour. Initial use is estimated at 250,000 vehicles daily and an initial travel of 600,000,000 miles annually. It is estimated that the saving to motorists in time and expense will amount to $16,000,000 annually. This figure does not include the enormous saving to business and industry in speeding up commercial deliveries.

The city can finance its $30,000,000 share of the $110,000,000 program without interference with its normal highway requirements. Cost of amortizing revenue notes is only slightly greater than present payments from motor fuel tax of $2,000,000 annually to the Board of Education. These diversion payments terminate in 1940. Cook County can likewise finance its $30,000,000 share of the program, having both motor fuel tax note and bonding power. The state can reasonably be expected to contribute part of its highway revenues, in the interest of providing adequate terminals for its statewide system. The federal Public Roads Administration is advocating that substantial federal financial assistance be extended for the acquisitions of rights-of-way for metropolitan superhighway projects.

In general the recommended plan for Congress St. that is contained in the subway report, as previously noted, contemplates eight wide traffic lanes. Between Wells St. and Racine Av. the structure would be elevated, while a depressed type of highway is suggested for the reach from Racine Av. to the city limits. In the terminal area east of Wells St. the improvement is planned for a 120-ft. width at street grade, with the widening between State St. and Michigan Av. confined for the present to cutting back sidewalks.

The design of the Congress St. superhighway incorporates all the features of a "limited access" thoroughfare including suitable entrances and exits, separation of opposing traffic streams, complete elimination of cross traffic and traffic signals, with no left turns, no pedestrians and no parking. Adequate ramps, modern lighting and wide landscaped areas on either side are contemplated. The design fully recognizes the desirability of enhancing values of areas traversed by the improvement.

It is estimated that this improvement will have a capacity of 6,000 vehicles per hour in a single direction, as compared with a liberal forecast of 4,000 per hour as the maximum initial use, or an excess capacity of 50 per cent.

The use, says the report, should be limited to high speed passenger vehicle traffic including express but not local buses. The transfer of these types of vehicles to the superhighway will relieve the surface streets of substantial volumes of traffic.

The total estimated cost of this west side superhighway (Michigan Av. to the city limits) is $31,465,000. From Wells St. to the city limits the cost is $26,465,000. In the subway zone only (Dearborn St. to Throop St.) the cost is estimated at $12,200,000. Included in all estimates are land, buildings and construction costs. Of the total estimated cost approximately 54 per per cent is for construction and 46 per cent for land and buildings.

Subway extensions

The ultimate subway plan proposes that the work of providing subways for Chicago be divided into four financing and construction

stages of which the first is now in progress. Mileages and estimated costs for the four are as follows: (1) 7.7 mi., $45,600,000; (2) 3.6 mi., $23,400,000; (3) 18.8 mi., $96,000,000; (4) 20.4 mi., $102,000,000.

The plan contemplates the construction of two-track subways, to be utilized for the operation of rapid transit trains. The exceptions to this general specification are the Jackson-Michigan-Washington loop, an underground street system designed for street car or bus operation and the single tube subway for express operation in Milwaukee Av. between Logan Square and Paulina St. The underground loop will make possible the removal of all east and west street car tracks in the central business district, a substantial contribution toward "thawing out" the existing street and bridge congestion in this most important traffic area.

The completion of the Lake St. and Congress St. subway extensions planned for construction immediately following the initial system will permit the removal of the Lake st. and Wabash Av. sides of the elevated loop. Following these subways, if the plan is adhered to, the construction of the Wells St. subway as recommended, will make possible the removal of the remainder of the elevated loop.

Subway extensions

The plan recognizes the desirability of doing away with elevated rapid transit operation as rapidly as it becomes feasible to replace these needed services with equal below-surface facilities. With this in mind all extensions of rapid transit service are planned as subways, even though intervening sections of elevated railway may of necessity remain temporarily. These routes are noted on Fig. 2.

It is Mr. Harrington's opinion that the full usefulness of the initial system of subways now under construction will not be realized until the subway connections to the Metropolitan and Lake St. branches of the Rapid Transit System are constructed. These two extensions are estimated to cost $11,700,000.

It is also recommended that the suggested east and west subways in Washington and Jackson Streets be provided at as early a date as feasible, inasmuch as these "underground streets" will provide improved service to approximately 156,000,000 people annually, will give the west side car riders access to the east side of the loop district and to the lake front, will provide subway connections between four major railroad stations, and will go far toward relieving loop congestion through the removal from the streets of all east and west street car tracks. The estimated cost of these two subways is $11,700,000.

The other subway extensions, it is contended, are needed in greater or less degree and should be built as rapidly as feasible, in the interest of extending rapid transit facilities to the greatest possible number.

Both reports were prepared under the direction of Mr. Harrington. The task of studying and developing the details of the superhighway report fell to Charles E. DeLeuw, consulting engineer for the city, W. R. Matthews, engineer for the department of public works, and A. J. Schafmayer, engineer for the board of local improvements.

Charles DeLeuw & Co. prepared the details of the subway extension report with the assistance and advice of R. F. Kelker, Jr., engineer of the city council committee on local transportation. Cooperation and assistance for both reports were given by federal, county and park agencies as well as Chicago Plan Commission and Chicago Regional Planning Association.

Noted Australian Bridge Must Be Rebuilt

The Hawkesbury River bridge of the government railways of New South Wales is in such condition as to need entire reconstruction, according to the annual report of the Department of Railways for the year ending June 30, 1939, and the government has been requested to provide the necessary funds for prompt action. The steel spans are inadequate for modern loading and several of the concrete piers are badly cracked. This bridge, built by American engineers and opened in 1889, consists of six truss spans of 410 ft. and one of 414 ft., while the foundation of one pier goes 162 ft. below water level; this was the deepest in the world at the time of construction. The spans were strengthened for heavier loading between 1926 and 1931.

Examinations of the piers showed increasing cracks in the piers, especially at No. 4 due to the clogging of the rollers of the expansion bearings. Some time ago a proposal was made to wind this pier with wire rope and to attach a steel cofferdam to the foundation caisson to permit building a reinforced-concrete sleeve around the masonry of the pier. On this sleeve was to be a steel structure for lifting the end of the spans and placing new expansion bearings with segmental rollers. Similar work was to be done at other piers. However, diamond-drill borings showed defective concrete in Pier No. 4, and this was confirmed by sinking a shaft 4 x 3 ft. to a depth of 54 ft. in the caisson. The iron caisson was corroded in places so as to admit salt water into the already defective concrete and so cause further disintegration. Subsequently, the shaft was filled with concrete and cement grout was pumped into the old concrete as a temporary measure. Inspection of the other five piers by divers showed that their iron caissons were badly corroded and that the proposed repairs were not practicable. There was also serious pitting of one of the steel truss pins, which could not be removed and replaced. For safety of operation, the bridge was converted to single-track operation and the masonry of pier No. 4 was strapped temporarily with steel girders. An entirely new structure is considered essential and must be provided as soon as possible. A site west of the present bridge has been selected and some preliminary work has been commenced.

Readers Vote "No" on WPA

FOR OVER TWO MONTHS readers have been sending in their votes on the question "Should WPA Continue in Construction?" which was discussed pro and con in *Engineering News-Record*, Aug. 31, 1939, p. 280, by Col. F. C. Harrington and W. A. Klinger. The prevailing answer is "No" by a substantial majority for every type of reader—contractors, consulting engineers, federal and state engineers, city and county engineers, teachers and a group unclassified as to occupation. In detail, the vote of 187 contractors was 25½ to 1 against WPA in construction; of 217 consulting engineers 6½ to 1; of 235 federal and state engineers 3 to 1; of 116 city and county engineers 1¾ to 1; of 20 teachers 4 to 1; and of 225 in the unclassified group 6¼ to 1.

Grouping all classifications together the vote was 4¾ to 1 against WPA, and if the contractors, whose overwhelming negative vote is not unexpected, are eliminated, WPA is still rejected by a majority of 4 to 1. It is significant to note that after the first 450 votes were in, no succeeding batch of 50 votes changed the results by more than 1 per cent. Statistically, therefore, it may be assumed that the results reflect the opinion of the entire readership of the magazine.

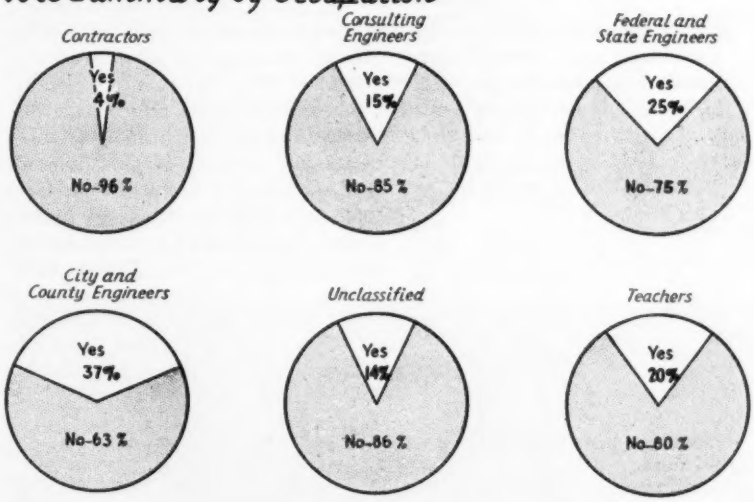
A general conclusion from the returns would be that voters made their decisions on the basis of self-interest; contractors like WPA least, city and county engineers most. Yet even the latter voted nearly 2 to 1 against the system which has financed most of their construction work during the past five years.

The results reveal no great difference of opinion as between different size cities or different parts of the country. Over one-half of the votes came from the small city group, while vote distribution over the country was fairly uniform. WPA is liked better in the very large cities, according to the vote, but even so was rejected 3 to 1.

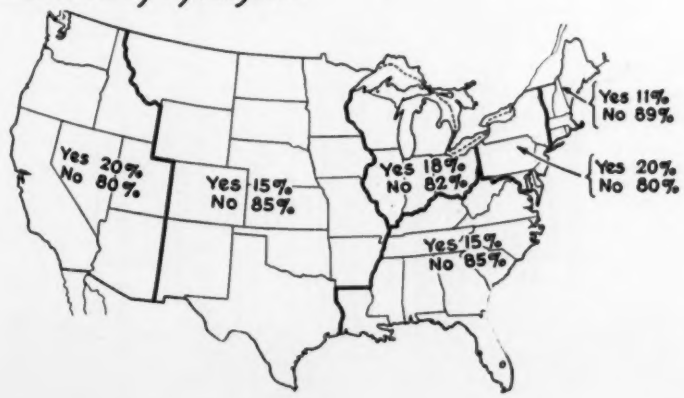
The results are presented graphically in adjoining column.

Should WPA Continue in Construction?

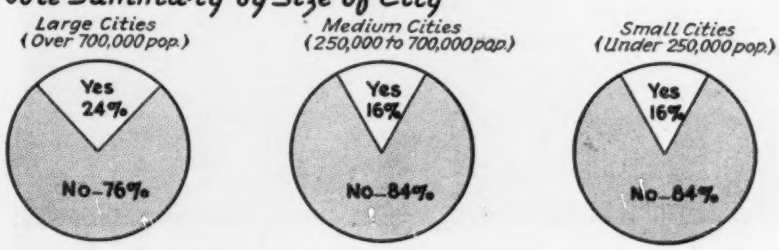
Vote Summary by Occupation



Vote Summary by Region



Vote Summary by Size of City



High Distribution Tank of Large Capacity

ALEXANDER POTTER and M. H. KLEGERMAN
Consulting Engineer Associate
New York City

Contents in Brief—The design of one of the highest, large-capacity water tanks in the country recently completed at Batavia, N. Y., called for careful study of foundation supports, column layout and wind bracing. Of special interest is the method used for the design of the central riser pipe to serve as a column.

TAKING a prominent place among the country's large elevated storage tanks is the 1,500,000-gal. steel tank and tower completed in July for the city of Batavia, N. Y. The tank diameter is 103 ft., water depth is 25 ft. and height of structure to the high water line is 169 ft.

Combined large capacity and height in distribution tanks, by which is meant storage volumes of 1,000,000 gal. or more and tower height of 100 ft. or more, is not very common. Table I, based upon information obtained from the three principal fabricators and erectors in this field of steel construction (June, 1939) indicates that only 22 structures in the United States can be included within this classification. The Batavia tank ranks first in order of total height of any structure of equal or greater capacity, and second in order of tower height of any tank recorded.

Fig. 1. Batavia, N. Y., water tank which ranks as one of the highest large-capacity tanks in the country.

Until the completion of the present tank, distribution was provided solely by pumping from the city's filter plant located about a mile from the fringes of the piping network. Failure in pumping equipment or in the supply main from the plant to the distribution system presented a potential danger for many years. The present structure will provide storage for fire protection purposes in the high value district as well as for other sections of the city, thus reducing insurance rates. In addition, it will improve hydraulic conditions in many parts of the system and will make possible pump operating efficiencies not previously feasible.

Foundation study

Heavy loads involved in structures of this kind (the water load alone being over 13,000,000 lb.) warranted thorough investigation of foundation conditions. In this instance, the formations underlying the 130-ft. square site were explored by 32 core borings and four test pits.

The site was found to be overlaid with an ash fill to a depth of about 4 ft., under which were deposits of sand and coarse gravel with occasional presence of clay. These formations became more compact as the depth increased so that it was impossible to advance the casing used in the core borings below an average depth of 14 ft. For greater boring depths core drilling was used. The greatest depth to which several of the borings were carried was 47 ft. and except for boulders encountered at the greater depths, the same general formation was found to exist.

Pits excavated to depths of 7, 8, 10 and 11.2 ft., respectively, were used for soil bearing capacity tests at these depths by the usual type of loading platforms. Bearing areas were 2 sq. ft. in each of three pits tested, and

1 sq. ft. in the other one of the four.

The bearing value selected for footing design was 5,000 lb. per sq. ft. The depth to which foundations were carried was selected as 12 ft. below ground surface. This depth was adhered to when excavations were made except for one footing on the river side which was carried down an additional 2.75 ft.

Footings were of stub column, spread type design as shown in Fig. 2. To reduce the soil pressures resulting from wind moment on footings to within the design limit, a system of reinforced concrete horizontal ties in the outer and inner ring of footings was introduced as well as radial ties between the stub columns of each ring of footings.

Levels taken prior to filling of tank and 12 hours after filling indicated the maximum settlement to be 0.02 ft., which occurred in one footing. Four footings settled 0.015 ft., six went down 0.01 ft., thirteen dropped 0.005 ft., and five showed no settlement. Platform tests had indicated a settlement of 0.025 ft. at design loadings (2 ft.-square bearing area). For the purpose of obtaining further settlement data, footing levels will be observed at monthly intervals for a period of about a year. (No change in relative settlement has occurred in four months.)

Tank and tower design

To permit maximum economy, considerable latitude was allowed bidders as regards number and arrangement of columns and roof and bottom details. Of three bids submitted, one design was based upon 52 columns, one upon 28, and one upon 16, the corresponding column loads (excluding total load to riser pipe) being 354,000 lb., 494,000 lb. (inner circle), and 712,000 lb. The bid was awarded to the Pittsburgh-Des Moines Steel Co., low bidder. Their design provided for two circles of columns, with 14 in each circle.

Welding was permitted in the following parts of the structure:

Bottom flat plates of tank (butt weld).

Bottom plates to supporting floor-beams.

Roof plates, including rafters (lap weld).

Connections of posts to base plates.

Central riser pipe (butt weld).

The joint efficiency for butt welds on the flat bottom and riser pipe was taken as 90 per cent. Rivets were used on the column connections, cylindrical tank plates and bottom plates.

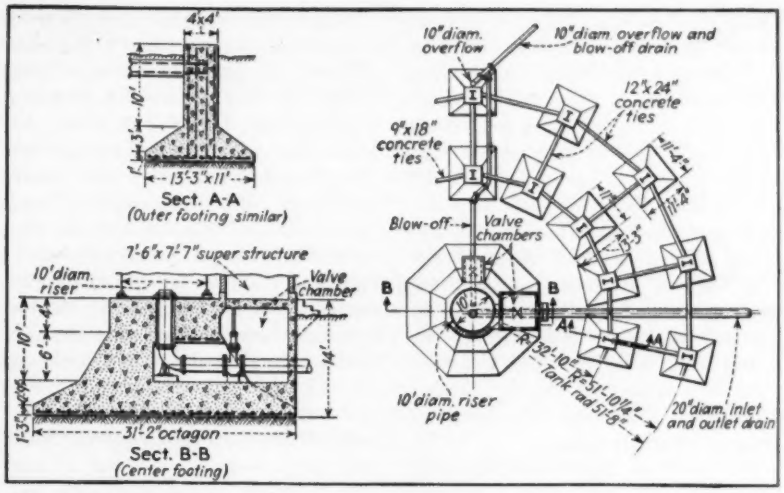


Fig. 2. Footings for the 28 columns were tied together with concrete beams in order to reduce soil pressure resulting from wind moment.

Columns are braced horizontally by means of circular girder or "Ferris-Wheel" bracing between the inner and outer row of columns at each of the strut levels. Outer columns are also provided with diagonal bracing in the vertical plane (circumferentially, not radially). Diagonal bracing consists of flat bars from $5\frac{1}{2}$ to 6 in. wide and $\frac{7}{16}$ to $\frac{1}{2}\frac{9}{2}$ in. thick.

This system of wind bracing design is intended to transmit the wind forces at the panel points to the outer ring, the wind bracing in the outer ring being designed to bring all the wind load on the tank and tower down to the foundations.

The 10-ft.-dia. central riser pipe in this design serves as a column, the plates of which are subjected to a heavy vertical load. The riser design was based generally upon the results of investigations conducted at the Engineering Experiment Station of the University of Illinois, which are reported in *Bulletins 255* and *292*.

However, some variations in the procedure outlined were made in the design for the reason that none of the reported tests dealt with a cylindrical shell (i.e., riser pipe) full of water, which is, of course, the condition in the operating structure. It was believed by the designers that the presence of water under considerable pressure in a riser pipe reduces its strength as a column. To compensate for the bursting stress produced by the head of water (which stress is at right angles to the principal compressive stress resulting from the column loads), that value which would otherwise be considered the safe working unit stress was reduced by $\frac{3}{10}$ of the calculated bursting stress (Poisson's ratio theory).

The plate thicknesses used were: top section, $\frac{5}{8}$ in.; middle section, $\frac{2}{3}\frac{1}{2}$ in.; bottom section, $\frac{1}{1}\frac{1}{6}$ in.; resulting in unit stresses of 6,870 lb., 6,814 lb., and 6,584 lb., respectively. These stresses are about one-third to one-quarter of the wrinkling stresses reported in *Bull. 292*, for plates of approximately corresponding values of t/R.

The connection between the bottom of the riser and the base of the riser is welded. On the assumption that this connection is a rigid unyielding one with respect to the angles be-

TABLE I—LARGE ELEVATED WATER STORAGE TANKS IN THE UNITED STATES

Capacity Mil. Gal.	Height of Tower Feet	Height to High Water Feet	Location	Year Built
2.0	125	160	Buffalo, N. Y.	1935
2.0	102	137	Winston-Salem, N. C.	1938
1.5	144	169	Batavia, N. Y.	1939
1.5	143	167	Milwaukee, Wis.	1929
1.5	134	158	Syosset, L. I.	1929
1.5	115	140	Durham, N. C.	1938
1.5	104	129	Manitowac, N. C.	1937
1.0	148	174	West Allis, Wis.	1930
1.0	143	169	Wauwatosa, Wis.	1928
1.0	144	159	Rockville Center, L. I.	1936
1.0	130	155	Freeport, L. I.	1937
1.0	135	151	Elyria, Ohio	1936
1.0	125	150	Newport News, Va.	1933
1.0	125	150	Phoebus, Va.	1935
1.0	115	140	Thomasville, N. C.	1934
1.0	122	138	Lake, Wis.	1938
1.0	110	136	Owensboro, Ky.	1938
1.0	110	135	Salina, Kan.	1935
1.0	103	128	Alberta Lea, Minn.	1938
1.0	100	125	Jacksonville, Fla.	1939
1.0	100	125	Rocky Mount, N. C.	1934
1.0	100	125	Wilson, N. C.	1938

tween the base and a vertical element of the riser surface, analysis indicated that the restraint caused by this rigid base connection, when reinforced by lugs welded to base and riser surface as is customary, might produce high stresses, possibly in excess of the elastic limit. It is believed by some that these lugs insure that the column loads will be transferred from the riser shell to the riser base as there can be provided sufficient area in the lugs to transfer the load without the assistance of a large part of the riser plate area, since two lugs with a portion of the riser shell between them form an effective column.

However, an important condition to be fulfilled, if excessive stresses are to be prevented, is that the free bulging of the riser walls under loads is not interfered with. It was the belief that the presence of the lugs would thus cause further restraint to the already rigid base connection. Accordingly, a welded angle connection, permitting flexibility at base of riser, was adopted in preference to stiffening lugs.

Tank appurtenances

Stairway—A spiral stairway, 24 in. wide with handrail on both sides, is provided from ground level to a point near the top of the riser, from which point a walkway extends horizontally to one of the main columns. From that point a ladderway extends vertically to a landing on a balcony which encircles the tank.

Ladders—Also provided are a revolving roof ladder and a fixed ladder on inside of tank as well as facilities for hanging painters' scaffolds.

Valve House—A brick valve house at the base of the riser permits access to valve chamber beneath and also to the spiral stairway.

Water Level Transmitters—Tank water levels are transmitted electrically over a private electric circuit to a recording gage in the filter plant and pumping station about 1½ miles from the tank. The transmitter is located in the valve house, pressure being obtained from the connection to the 20-in. inlet-outlet pipe. A mercury U-tube arrangement is provided to compensate for water column from tank bottom to the main. A high- and low-water alarm is also installed at the pumping station, integral with this equipment.

Paint—All exterior and interior surfaces of steel received a shopcoat of paint consisting of red lead, red oxide of iron and silica-graphite pigment with boiled linseed oil vehicle. The tower and riser exterior was provided with two field coats consisting of silica-graphite and boiled linseed oil, the second coat containing 14 per cent (pigment) carbon black. The tank exterior was painted (first field coat) with an aluminimum powder-silica graphite pigment in a vehicle of 100 per cent long oil spar varnish. The second field coat on tank exterior, which was also used as the first field coat for tank and riser interior, consisted of the same pigment as the foregoing, except in different proportions, with vehicle being 100 per cent long oil spar varnish. The final field coat on tank and riser interior consisted of 100 per cent aluminum powder in 100 per cent spar varnish, the vehicle representing 81.3 per cent of the paint.

The total cost of the structure, financed in part with a PWA grant, was $143,761; of this amount the tank and tower cost $124,700, the foundations $18,261 and the water level transmitter $800.

Acknowledgement

The work was done under the supervision of Alexander Potter, consulting engineer, New York City, who was represented in the field on construction by F. S. Rasmussen and J. A. Wold, Pittsburgh-Des Moines Steel Co., of Pittsburgh, Pa., G. L. Christy, chief engineer, were contractors for fabrication and erection.

A.S.T.M. Approves New Standards

AT ITS RECENT MEETING at headquarters of the American Society for Testing Materials in Philadelphia, the society's committee E-10 on standards acted on a large number of recommendations from the standing committees on materials. Quite a number of the actions resulted from the desire of various committees to have their existing specifications and tests in the best possible shape for inclusion in the 1939 Book of A.S.T.M. Standards, which will be available late in November. Among the actions of the committee are the following:

On the recommendation of committee A-3 on cast iron, new tentative specifications for cast-iron soil pipe and fittings to replace the present standard (A 74—29) were approved as well as new specifications for cast-iron pit-cast pipe for water or other liquids, replacing specifications A 44—04, which have stood since 1904 without revision.

A change in the absorption requirement of sewer brick made from clay or shale (C 32—37 T) was approved at the suggestion of committee C-15 on manufactured masonry units, to take account of the fact that in some sections of the country products with high compressive strength, which did not pass the existing absorption requirements, have been in successful use. Present requirements for maximum water absorption by 5-hr. boiling, average of five bricks, are as follows: Grade SA, 6 per cent; Grade MA, 12 per cent; Grade NA, 20 per cent. The change provides that bricks with an absorption between 12 and 20 per cent shall be graded MA if the compressive strength conforms to the 8,000 lb. per sq. in. requirement for Grade SA.

Tentative specifications for building brick made from clay or shale (C 62—37 T) were revised to incorporate more rigid requirements on strength, absorption, and saturation coefficient and to include a freezing and thawing test method. Complete details of the freezing and thawing test were approved as a tentative revision of the standard methods of testing brick (C67—37).

In its report presented at the society's annual meeting, committee D-4 on road and paving materials included for information a proposed test for sieve analysis of mineral filler (D 546—39 T), methods of

testing preformed expansion joint fillers for concrete (D 545—39 T) and specifications for preformed expansion joint fillers for concrete (D 544—39 T). These three items were approved at the E-10 meeting as tentative and will appear in the 1939 book of Standards. The specifications cover non-extruding and resilient types of the following four classes: cork, self-expanding cork, sponge rubber, and cork rubber.

Acting on proposals made by the Society's committee E-7 on radiographic testing, the standards committee approved new tentative recommended practice for radiographic testing of metal castings (E 15—39 T), which will replace immediately the present standard E 15—29. The older practice has not been changed for several years, and it was considered essential that it be brought up to date. This method covers general considerations, defects that may be revealed by radiography, radiographic equipment, and radiographic technique—each of these sections being classified under X-rays and gamma rays.

Water-Power Dam in Sweden Formed of Concrete Monoliths

Contents in Brief—Use of T-shaped monoliths for a dam exposed to low temperatures shows economies in cost and is expected to reduce deterioration and maintenance troubles. Steel and concrete used in temporary dam.

CONCRETE MONOLITH BLOCKS, T-shaped in plan and poured in place, constitute the main part of a new gravity dam for power development on the Indal River in Sweden. With the heads in contact to form the upstream face, there are open spaces between the "stems" of the blocks, thus effecting an appreciable saving in volume of concrete as compared with a dam of solid concrete. These open spaces are drained and are covered by planking in order to reduce temperature variations. During the winter, warm air from the generator ventilating system is passed through longitudinal ducts in the dam. For the spillway portion, the monoliths are I-shaped, so that both faces of the dam are closed and sealed, leaving isolated cells between the "webs" of the blocks. In Fig. 1 are shown the general design of the main dam and the overflow or spillway portion, together with details of the joints between the monoliths. The monoliths, spaced 19.68 ft. center to center, have heads of this width, while the stems and webs are 11.48 ft. wide, and 8. ft. apart in the clear.

This dam, 300 mi. north of Stockholm, is one of the main elements of an extensive hydro-electric project being carried out by the Krangede Co. As described in *The Engineer*, London, from which the present information is condensed, this plant utilizes a total head of nearly 200 ft., formed by 2½ mi. of falls and rapids. The dam is 720 ft. long, with a maximum height of 60 ft. above the granite foundation. To provide against uplift due to horizontal seams in the rock, the trench for the cutoff wall under the upstream toe was sealed by grouting, after which drain holes were drilled into the rock in the open spaces between the monoliths and behind the cutoff. Some reinforcement is placed in the sides and faces of the blocks to prevent cracks which might result from uneven distribution of temperature during construction, and from future low winter temperatures. The joints between the monoliths serve as contraction joints.

In the upstream face joints, which are 3.28 ft. deep from the face, the contact surfaces are made with a vertical shear lock or mortice, as shown, and a Z-shaped bent plate of stainless steel is embedded in the two monoliths. The joints in this plate are welded electrically in the field. On the water side of this plate the concrete surface is covered with bituminous sheeting or felt, applied with hot asphalt and again coated with hot asphalt when the concrete for the adjacent block is poured. Behind the sealing plate, the surface is simply coated with asphalt. In the downstream joints in the spill-

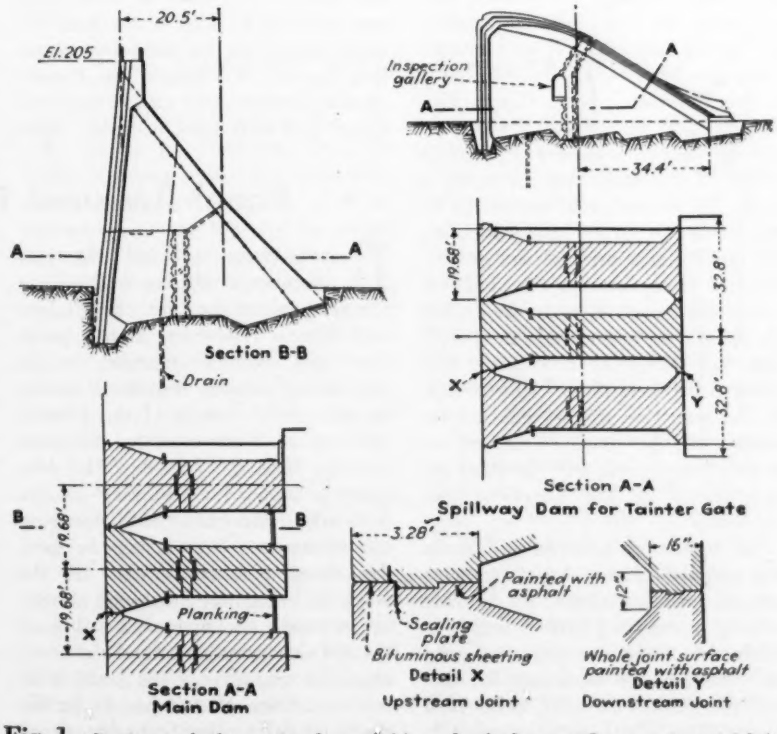


Fig. 1. Sections of the main dam (left) and of the overflow section (right), showing the form of concrete monoliths.

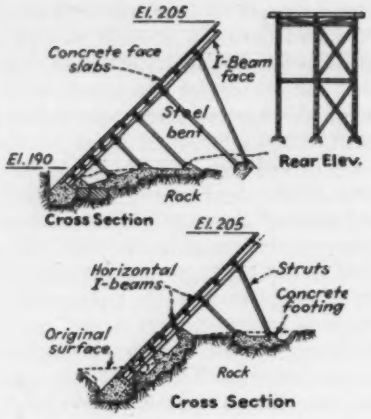


Fig. 2. An opening left for future water intakes is closed off with a temporary dam of steel and concrete.

way, which are 16 in. deep, there is also the vertical notch or shear lock and the whole contact surface is painted with asphalt.

Advantages of this construction of a gravity dam with T and I-shaped blocks have been summarized as follows: (1) utilizing the comparatively simple construction of the gravity type of dam; (2) reduction of uplift, with consequent saving in volume and cost as compared with a solid dam; (3) simplification of the conditions for stability; (4) prevention of water percolating through the downstream portion of the dam, thus eliminating the risk of deterioration of concrete, which has been experienced in dams on Scandinavian rivers; (5) facility of inspection and repair; (6) preventing, as far as possible, the formation of shrinkage and temperature cracks by allowing the monoliths to expand and contract independently; (7) facility of control of the generation and dissipation of the chemical heat in the concrete. As to the saving in concrete, as compared with a solid dam, the saving in volume in this case was between 20 and 30 per cent, but the reduction in cost was less on account of the greater amount of formwork required and the steel reinforcement in the faces of the monoliths.

The spillway, between the main dam and the intakes, has four gates and an open log chute. To provide stability in resisting lateral forces to which the gates are subjected, the gate openings are separated by concrete piers 16.40 ft. wide, reinforced on the faces. Each gate opening is 65.6 ft. wide, with its sill 23 ft. below crest level of the dam. The log chute is 29.5 ft. wide and 14.76 ft. deep. Three of the gates are of the Tainter type, which open by rising above the sill, the water flowing under the gate. The other is a sector overflow gate, which opens by lowering into a pit, so as to discharge floating ice and drift with a minimum flow of water. A sector gate may be fitted later to the log chute. All the gates are electrically operated, and two of the Tainter gates are fitted for remote control from the power house.

From a row of intakes fitted with Tainter gates the water flows through vertical penstocks 18 ft. in diameter, excavated in rock and lined with steel plates electrically welded. The turbines are in an underground rock chamber, 130 ft. below the ground, with the generators on the upper floor of the chamber. From the draft tubes there is a tail-race tunnel 4,750 ft. long, with a base width of 36 ft., tapering sharply towards the crown in a height of 50 ft. The narrow crown is at such an elevation that the tailwater will have free flow even when the river is at flood level. This tunnel serves the present three turbines, and will be duplicated when the future three are installed to complete the plant.

Concrete for parts of the work that would be exposed to water pressure was made with a low-heat cement containing an artificial puzzolana known as Pansar. The Pansar cement hardens more slowly and generates less heat than ordinary portland cement, and makes a concrete of high resistance to dissolution of lime.

A temporary length of dam composed of steel bents with concrete facing slabs is a specially interesting part of the project. The intakes are located in a reinforced concrete structure forming an extension of the dam, but at present there are only three intakes for the three power units. To close the unexcavated space left for the future three intakes, this steel and concrete dam was erected on the present rock surface. As shown in Fig. 2, it consists of steel bents having I-beams 13 ft. apart and inclined about 45 deg. the beam being supported by steel struts seated on concrete footings. Horizontal I-beams are framed between and in front of the face beams, and at intervals there is diagonal longitudinal bracing, as shown.

Uplift is resisted by anchor rods riveted to the webs of the face beams and extending 4 ft. into the concrete toe, the ends of these rods being hooked for mechanical bond in the concrete. Concrete slabs anchored to the inclined face beams are backed by wooden lining, a narrow space being left between the wood and the concrete to form a conduit into which warm air from the power house may be directed.

In the design and construction of the Indal River Dam, the firm of Vattenbyggnadsbyran, of Stockholm, acted as consulting engineers for the Krangede Co.

Canal Restored for Pleasure Use

RESTORATION of the old and abandoned Illinois & Michigan Canal (connecting the DesPlaines and Illinois rivers) as a state parkway and boating channel is an interesting project described briefly in the annual report of the Illinois Division of Waterways for the year ending June 30, 1938. The program provides for restoring all the hydraulic structures and dredging the channel so that it can be used for small pleasure craft. All the work is being done in such a way as to retain the historical value of the old structures, although in some cases the masonry of the locks is in such condition that it has to be entirely rebuilt, using concrete faced with stone to represent the old work. In other cases, deteriorated stones are replaced with new blocks. New lock gates are built to the old designs.

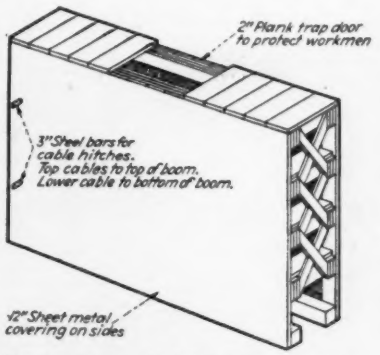
Reconstruction of the towpaths as drives necessitates the erection of fences to exclude cattle from the canal property. Improvement of the office building at Lockport, built in 1837, is based on the old plans, and will provide space for offices and a museum. Recreational work supplementing this project includes landscaping, parking and picnic areas, fishing pools, and foot trails as well as drives laid out for scenic effects. A somewhat similar but much less extensive recreational project under way is the construction of a boat channel connecting a series of lakes in the Fox River valley.

Caving Sewer Trenches Whipped

Contents in Brief—Quicksand at New Shawneetown stopped hand trenching and hindered machine work, and swelling bottom floated the sewer pipe. This was met by pulling a working box along the trench behind an excavator, laying pipe within the box and backfilling behind it. Manholes built as open caissons.

CAVING TRENCHES made sewer construction by the common methods nearly an impossibility in building New Shawneetown in Illinois. The high ground to which the flood-ravaged Ohio River community has been removed consists of a fine, wet, mobile sand with almost no stationary qualities when unconfined. A sewer system for the new town required this material to be trenched to depths of 14 to 24 ft. for main sewers and nowhere would a trench more than 4 or 5 ft. deep stand without bracing. Also, after a few hours the bottom of the trench would start to lift; pipe left uncovered by a substantial backfill floated up 18 to 20 in. overnight.

Construction was started by hand, this being WPA work, but the expense and hazard soon led to the installation of a trench excavator. Even this as normally operated failed to meet the conditions. The trenches caved to 25 to 30 ft. wide at the top and for a 15-in. pipe the excavation ran to 8 to 10 cu. yd. per ft. of trench. Overloading threatened the breakdown of the trench excavator. A remedy was found in a box, shown conventionally by the accompanying sketch, pulled by the excavator ladder along the bottom of the trench. The pipe was laid and jointed in the box which held the trench sides temporarily and protected the work and workmen from bank slides. The excavator loaded directly into trucks which dumped close behind the box and kept the trench backfilled. By this arrangement 200 to 400 ft. of sewer were completed in an 8-hr. shift and no trouble was had with floating pipe, but this last trouble was fully avoided only when continuous operation for 24 hr. a day was adopted. Lights were installed on the trench and in the box for night work.


2" Plank trap door to protect workmen
3" Steel bars for cable hitches. Top cables to top of boom. Lower cable to bottom of boom.
12" Sheet metal covering on sides

Trailer box pulled by trench excavator solved quicksand trenching difficulties in New Shawneetown sewer construction.

This method of digging the trench, laying the tile and backfilling in one operation made impracticable the usual practice of leaving an open section of trench at each manhole. The quicksand would have heaved any length of pipe so left. Manhole construction was therefore made a second operation. The bottom of the manhole was precast so as to fit the sewer line and sunk as a caisson by workmen digging within the ring. This section was about 5 ft. high. As it sank into the ground a section of form was placed on top and a 4-ft. section of manhole shaft was concreted. Then the digging was resumed (the manhole shell being reinforced) until time to cast another section of shaft. A special conical form was used to cast the upper section, reducing the shaft size to fit a standard manhole cover. When the initial or bottom section was seated on the sewer line, the bottom of the manhole was concreted and the tile line was opened for cleaning, rodding, etc. This was found an easy way to build manholes in such soil, well adapted to hand labor such as WPA employs and very reasonable in cost. The sheeted, braced and pumped pit that would have been necessary without this method would have been quite expensive in such soil at depths of 12 to 24 ft. The cost averaged $130 per manhole.

The box illustrated was devised by Capt. F. H. Morgan, general superintendent, and T. J. Prendergast, sewer and water superintendent. All work was done by WPA forces.

Sawmill Waste Covers Fills

A TRUCK GARDENER on the outskirts of Portland, Ore., recently obtained a fill 13 ft. deep over several acres of land by allowing scavengers to use the site for refuse disposal. The location is such that the haul was shorter than to the sanitary fill maintained by the city. The usual cost of necessary cover material was obviated by using mill waste from a nearby cedar shingle mill. This waste, ordinarily burned, was available without charge and consisted largely of broken shingles and small wood scraps. It was dumped and spread over the fill after a bulldozer, supplied by the scavenger, had leveled and somewhat compacted the freshly dumped garbage. Thus the only expense to the land owner was trucking in the mill waste (a haul of less than a mile) and supervising the filling. Only selected loads, containing no rough material, offal, fruit or market waste were accepted at the fill.

Because of the heat which is generated by garbage decomposition in deep fills it was thought advisable to take precautions against fire in the inflammable cover material. Each garbage layer was limited to a depth of 6 ft. Over each layer the mill waste was spread and compacted to a final depth of 6 in. Water barrels at convenient points around the edge of the fill were kept full for use in case of fire.

Because of the convenient location, a major portion of Portland's garbage was delivered to this site for a time, advancing the fill at the rate of 350 to 400 cu. yd. per day, (about 4 cu. yd. of garbage per ton). After the fill was completed a 3-ft. cover of topsoil was put on.

The use of mill refuse for cover is not an approved method for sanitary fills made by the city of Portland, which stipulates earth cover. (See *ENR*, Sept. 28, 1939, p. 412.)

FIG. 1. NEW SIX-LANE DIVIDED HIGHWAY BRIDGE CROSSING BUSY NEWTOWN CREEK AT NEW YORK CITY.

New York's Latest Interborough Bridge

NATHAN DEUTSCHMAN
Department of Public Works, New York City

***Contents in Brief**—Structural details of $4,500,000 bridge connecting Brooklyn and Queens over one of the city's busiest waterways. Acid soil required special foundation design and alkalizing procedure. Unusual method of installing heavy steel bracing for large cofferdams. Tieback cantilever erection method for high-level channel span.*

THE MEEKER AVE. BRIDGE recently opened for traffic provides another needed thoroughfare over water between the boroughs of New York City. Connecting Brooklyn and Queens over Newtown Creek, a busy waterway, the bridge is 6,415 ft. long, of which virtually only 300 ft., the high level span over Newtown Creek, crosses water. While expensive and heavy work was involved throughout, the exceptional construction problems centered near and at the foundations for the river span, where a highly acid soil called for special protective work, and in the erection of the high-level steel over a waterway the full width of which had to be kept clear for navigation. Description here is confined largely to the special work; technical data about the bridge structure follow in an appendix.

Acid soil alters plans

The planned foundations for the approach viaduct piers (see appendix) were cast-in-place concrete piles, and the greater number of piers have these foundations. But on the Queens approach for several piers near Newtown Creek the piles were abandoned. After the first pier near the creek was completed and most of the piles for the second pier were driven, it was discovered that the soil contained acid. The color of the water and the fact that pumps were corroded after a short period of use led to a sample being taken and tested. This sample was found to have a pH of 2.5, this being highly acid and injurious to steel and concrete.

On investigation, the source of this pollution was found to be the storage on the ground in this area about ten years ago of a chemical by-product. A contract was let for borings with a provision that water samples for testing be taken at intervals of 10 ft. to an average depth of about 50 ft. These tests showed a definite acid condition in six pier locations. It was deemed advisable, therefore, to protect the footings and it was determined that this could be properly done only by eliminating the piles and carrying the footings to a considerably greater depth where good bearing conditions could be had.

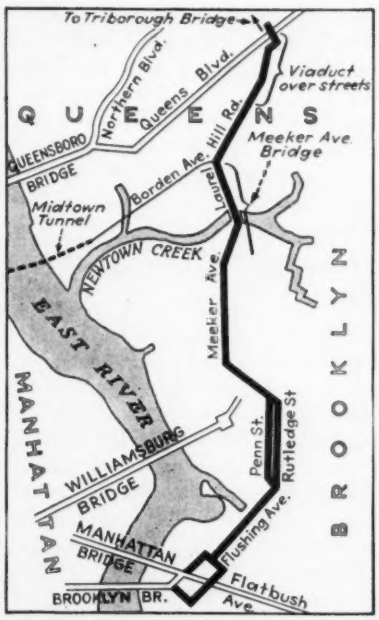
Three-ply membrane waterproofing was used at the base of the footings and for a height of 3 ft. around the sides, and the balance of the footings and the pier shafts were painted with

two coats of cutback asphalt up to within 1 ft. of the proposed ground surface. This treatment was applied to four piers, the construction of which was temporarily delayed pending the outcome of the investigation. All the sides of the previously completed footings and pier shafts were painted with two coats of asphalt and the backfill was mixed with hydrated lime, in the proportion of 2 bags of lime to 1 cu.yd. of backfill. The lime is expected to aid in neutralizing any acid in the soil around the footings.

Novel cofferdam construction

As shown by Fig. 4, the channel span is carried by braced steel towers on concrete piers. Both piers were built in steel sheetpile cofferdams about 130 ft. long and 47 ft. wide, Fig. 2. The distances between the faces of the piers is 250 ft. and between the centers 300 ft. The Queens pier extends to a depth of —40 mhw and is supported on 549 steel H-beam piles (Fig. 3) from 55 to 65 ft. long. The Brooklyn pier extends to a depth of —48 mhw and rests on good bearing soil.

The bottom of the river at each pier was leveled off by dredging, and 8 test piles were driven to determine the pile length. A line of temporary wooden piles was driven around the outside of the cofferdam and cut off to El. +21; another line was driven inside the cofferdam with piles opposite the outside piles. The piles on the inside were cut off at +4. Wooden battens 3x10 in. were spiked to the two lines of piles at El. +3 to form a platform on which to erect the steel interior bracing of the cofferdam. The total weight of the bracing when completed was 160 tons.



Brooklyn-Queens connecting highway and Meeker Ave. Bridge

After three tiers of the bracing were assembled on the temporary platform, the construction of the cofferdam walls commenced; interlocking steel piles 54 ft. long and 16 in. wide with a 5-in. arched web were used. The sheetpiles were guided to proper alignment on the outside by the wales and on the inside by the steel bracing.

After the sheeting was driven to El. —34, the load of the steel bracing was transferred to four 60-ton hydraulic jacks mounted on four elevated platforms inside the cofferdam, carried by clusters of four piles (Fig. 2). The battens between the outside and inside of the cofferdam were removed and the excavation proceeded to El. —22. The hydraulic jacks were inserted between lowering channels from which the steel framework was suspended. The steel bracing consisted of four tiers, 35 ft. in height when in final position, the first tier at +3, the second at —14, the third at —22, and the fourth at —32. The first three tiers were erected as a single unit; the fourth and lowest tier was an independent unit, and was temporarily supported in a position immediately below the third tier by lashings to the second tier; it was $1\frac{1}{2}$ in. shorter on all sides to prevent it from binding against the sheetpiling.

The 60-ton hydraulic jacks were seated upon grillages made up of two 15-in. steel channels. On the side of each channel was a vertical 10-in. sliding channel to which the steel framework was attached. These channels were 39 ft. high and about 17 ft. above the first tier. On top of each jack was mounted a billet with one side flat and the other with a semicircular groove which engaged a $2\frac{1}{16}$-in. removable steel pin. The vertical suspender channels had 3-in. circular holes spaced $10\frac{1}{2}$ in. on centers. The two 15-in. steel channels on the platforms also had 3-in. circular holes. On a platform in the center of the cofferdam was installed a hand-operated oil pump which was connected to each jack by copper tubing. Each tube had a control valve to operate each jack independently. As a safety precaution 1-in. shims were placed on each side of the jacks on shoulders built up from the grillages.

The lowering of the bracing was accomplished in drops of $10\frac{1}{2}$ in. or the distance between the holes in the vertical channels. Two pins were used for each lowering device. The plunger of each jack was forced up to the top pin in the vertical chan-

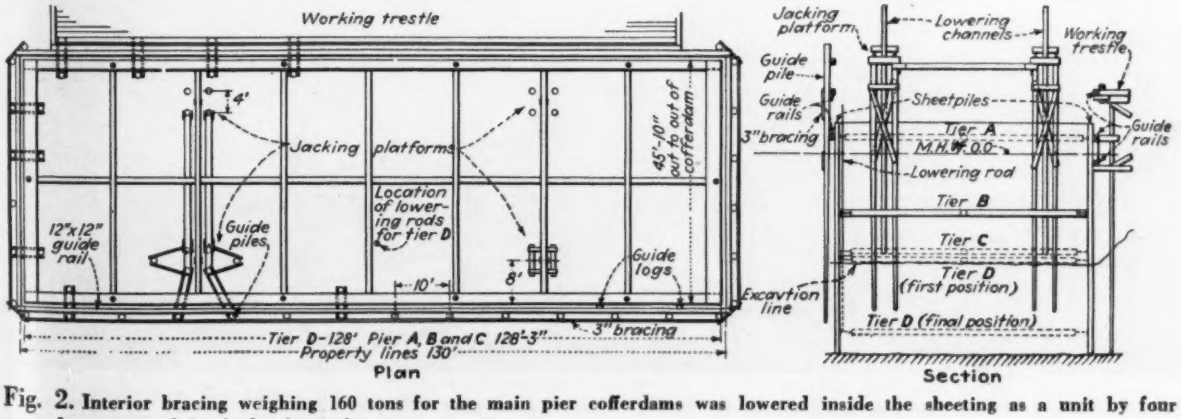


Fig. 2. Interior bracing weighing 160 tons for the main pier cofferdams was lowered inside the sheeting as a unit by four suspenders operated by hydraulic jacks.

nels, transferring load to the jacks. The lower pin in the grillage was then removed and the plungers were allowed to recede gradually, thus lowering the steel 10½ in. The bottom pin was then inserted through the grillage and the load transferred to the bottom pin. The top pin was removed and advanced to the next set of holes in the vertical suspenders. By this method the bracing was lowered about 22 ft.

When the third tier had reached its proper grade, the sheet-piling was driven home to El. —48 on the Queens side and to El. —58 on the Brooklyn side. The sheeting for the Brooklyn cofferdam was 64 ft. long. From brackets on the upper tier of the bracing, vertical 1¼-in. steel rods about 38 ft. long and threaded for a distance of 17 ft. at their tops extended down to connect with the fourth tier. The fourth and last tier was lowered to its final grade while the cofferdam was being excavated, by turning nuts on the threaded rods.

After the fourth tier was lowered to its final position, the Queens cofferdam was excavated to —41, and the Brooklyn cofferdam to —48. The steel H-beam piles were driven in the Queens cofferdam and tremie concrete was poured to El. —28. The bottom of the Brooklyn cofferdam was sealed with tremie concrete to El. —24. The cofferdams were unwatered about three days after the seals were poured and the construction of the rest of the piers was completed in the dry. The steel sheeting was burned off under water on the channel sides to El. —28 and on the other three sides as required.

Erecting channel span

The first operation for the erection of the main span (Fig. 4) was to erect a temporary toggle bent over each tower support. The toggle bent consisted of a steel frame made up of two vertical posts 65 ft. high braced by two horizontal steel struts and a diagonal member between the horizontal struts. From the top of each post backstays in the form of eyebars were connected to temporary frames attached to the adjacent approach span trusses, counterweights being suspended from the approach span trusses to resist the uplift. On the Brooklyn side a counterweight of 200 tons was required, and 125 tons on the Queens side.

Two derrick travelers with 90-ft. booms and 20-ft. jibs capable of lifting 30 tons were used to erect the two halves of the span in three stages. Stage one consisted in advancing the travelers to the ends of the approach spans and erecting the end posts of the trusses, connecting the tops to the erection bent by auxiliary eyebars. With the end posts in place, erection of subsequent members proceeded to panel points L2. The travelers were then advanced to panel points L1 and the second stage of erection commenced. To prevent the trusses from swaying the top members of the portal struts were erected temporarily. In the second stage the top chords were attached at panel points U3 to the erection bents by eyebars, and the auxiliary eyebars were cut loose. The erected portions of the trusses were raised by hydraulic jacks placed in the main set of ties to secure proper clearance. The travelers were then moved ahead and the erection of the remaining halves of the trusses together with the floorbeams and bottom laterals was completed. At this stage there was a space of about 5 in. between the truss sections.

Trusses jacked to place

The trusses were then swung into their final position by eight hydraulic jacks. One set of four jacks was placed in line with the bottom chords for shifting the truss sections forward and the vertical alignment of the trusses was adjusted with the jacks in the main ties. After the bottom

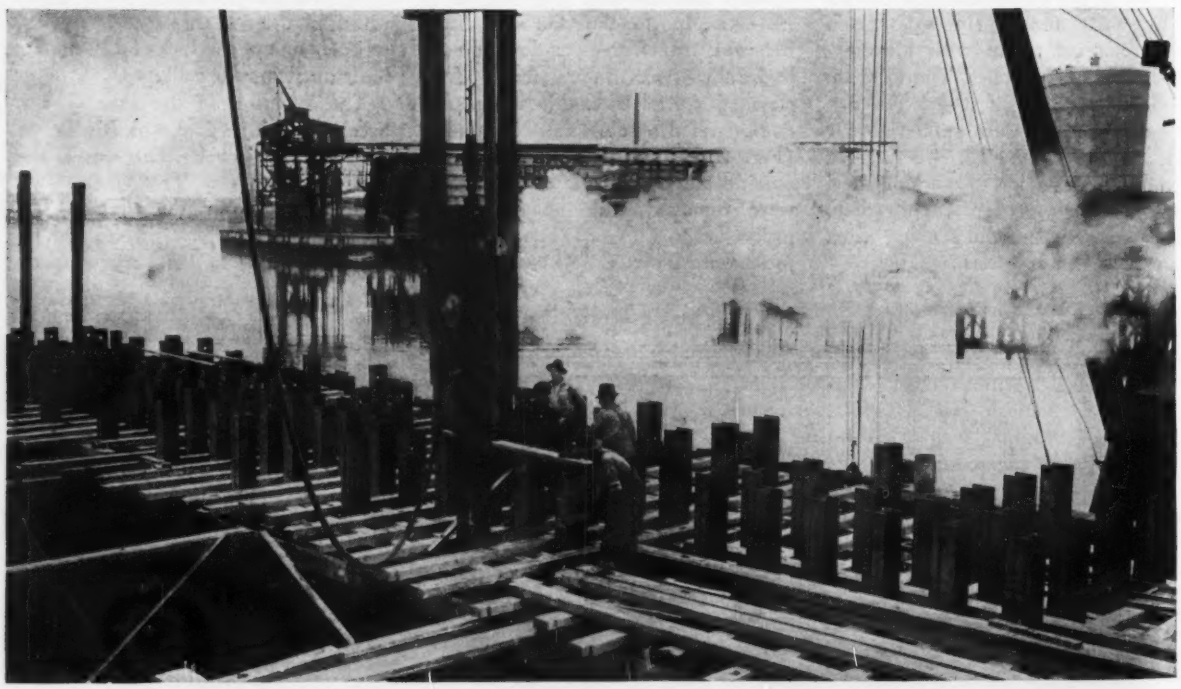


Fig. 3. Driving 549 steel H-beam piles 55 and 65 ft. long in the Queens pier cofferdam was a high spot in the substructure construction for the Newtown Creek bridge.

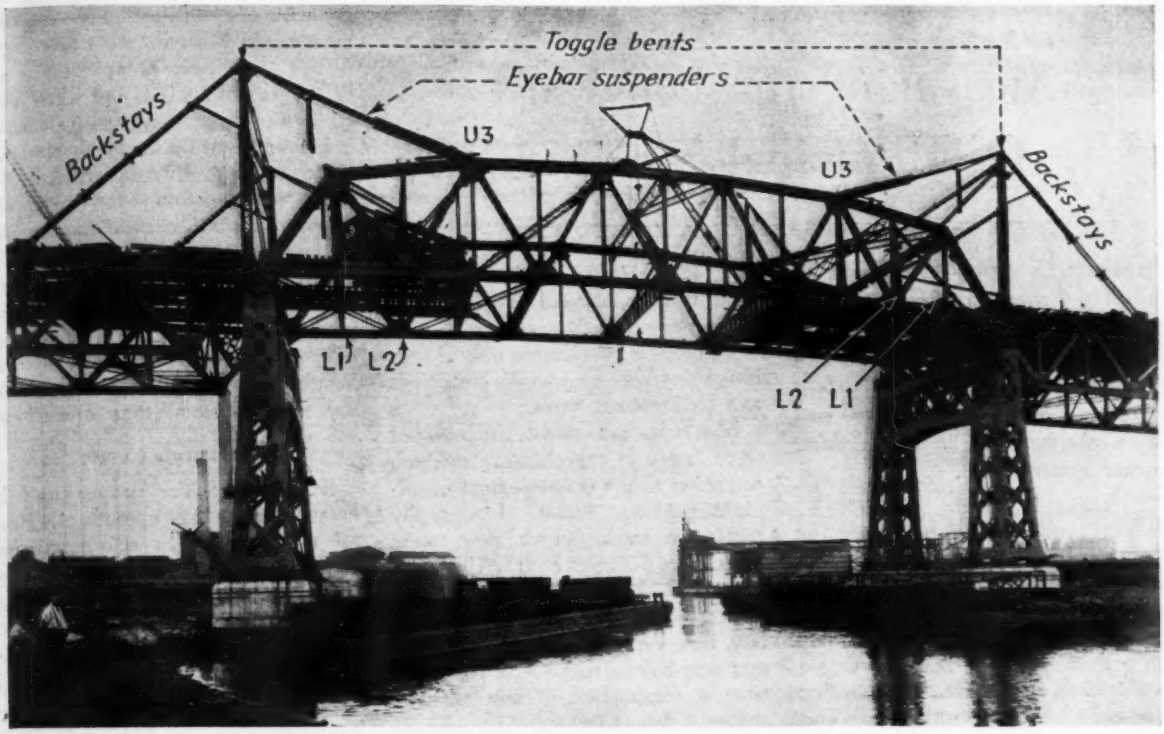


Fig. 4. Using tiebacks to counterweighted approach spans the channel span was erected as a cantilever 125 ft. high over an unimpeded waterway.

and top chords were connected and the last floorbeam set in place the eyebars were loosened and the travelers were moved backward filling in the remainder of the bracing and floor steel. After the travelers were again over the approach spans, they were used to erect the portals at each end of the trusses and also for dismantling the erection bents. The travelers were then dismantled by a crawler crane used for handling light members of the steel structure.

Erection of the two viaducts, main span and the two towers involving 17,000 tons of steel was accomplished in about four months.

Personnel

The Meeker Ave. Bridge was built for the city of New York from designs by the Department of Public Works, under the direction of Commissioner Irving V. A. Huie, Deputy Commissioner Homer R. Seely and Chief Engineer J. Frank Johnson. Construction was carried out by four contractors: river span piers, Charles F. Vachris, Inc.; approach piers and the Brooklyn ramp, Reiss & Weinsier, Inc.; Queens ramp, Elmhurst Contracting Co.; and superstructure, American Bridge Co. The writer was resident engineer.

TECHNICAL DATA ON NEW MEEKER AVE. BRIDGE, NEW YORK

The new Meeker Ave. Bridge over Newtown Creek connecting the boroughs of Brooklyn and Queens, is a vital link in a new 7-mile highway that taps the approaches to all of the East River Bridges and the new midtown tunnel, as shown on the accompanying map. Queens Blvd., its present terminus, gives access to the Long Island parkways, and it is planned to extend it to the Triborough Bridge.

The bridge with its approaches will be 6,415 ft. long; the greater part is 89 ft. wide and consists of two roadways each 32 ft. wide separated by a middle aisle 4 ft. wide and flanked by two sidewalks each 8 ft. wide. The essential structures are a closed ramp and a viaduct approach at each end and a center span over Newtown Creek.

Ramps—The Brooklyn Ramp, 2,142 ft. long, consists of a concrete roadway deck on floorbeams and stringers supported on columns on concrete footings. The sides of the ramp are faced with curtain walls to form a closed structure. There are two marginal ramps and three rigid-frame arches span three intersecting streets. For the support of the falsework the contractor elected to use steel brackets attached to the concrete columns at the top. Screw jacks mounted on top of the steel brackets were used for adjusting the forms for elevation. After the concrete was poured the brackets were removed and the holes in the columns plugged with mortar.

The Queens ramp is 750 ft. long and is similar in design to the Brooklyn ramp, except that it has no marginal ramps, and only one rigid-frame arch.

Viaduct Approaches—The Queens approach consists of deck trusses with the following spans: five of 120 ft., four of 159 ft., one of 198 ft., and one of 230 ft. The Brooklyn approach has four spans 120 ft. long, four 159 ft., one 216 ft. and one 230 ft. Falsework bents of steel or timber were used for the erection of the approach spans.

There are 21 land piers; each consists of two concrete shafts either on spread footings or on concrete cast-in-place piles. The high shafts are joined together at the top by arched beams about 16 ft. high.

Main Span—The main span 300 ft. long is supported on two steel towers 97 ft. high. It has a 4-ft. camber and is 43 ft. high. It has a maximum clearance of 125 ft. above mean high water. The trusses are spaced 75 ft. 10 in. on centers. The erection of the main span presented a difficult problem to the contractor because falsework could not be used due to interference of heavy marine traffic. After considerable study, the contractor elected to employ the cantilever method as has been described.

Quantities and Costs—The principal quantities involved were: Excavation 156,000 cu.yd.; concrete 88,120 cu.yd.; reinforcing steel 4,725 tons; structural steel, 16,315 tons. The cost of the bridge, including $606,720 for land, will be $5,588,582.

Measuring the Unit Cost Of Municipal Services

Contents in Brief—Unit costs of municipal works and activities are a useful yardstick, but they must be applied with care as a measure of administrative efficiency. Here are some of the limitations and problems incident to establishing a cost system.

DETERMINATION of unit costs for various kinds of municipal work is highly desirable in municipal activities, and such costs may be used to advantage in promoting economy and efficiency. There is, however, no established or standard accounting system by which to measure cost and efficiency, so that any comparisons of cost of the same class of work in different cities are practically worthless. In the absence of such a standard or yardstick, there is inevitably extreme variation in the factors and methods included in the accounting systems, and any one system is of value principally in the city where it has been developed. But while a yardstick for the measurement of costs is obviously desirable, the many difficulties and problems incident to the establishment of any cost system, even for an individual city, are not generally recognized. These statements present the theme of a recent address before the Governmental Research Association by Frank W. Herring, executive director of the American Public Works Association. Some of the leading arguments are summarized in the following.

Street cleaning costs

Consider street cleaning, as an example. For this work an established cost unit is the cleaning mile, or one mile of street cleaned once. But this unit measures only the amount of the cleaning activity; it gives no indication of the efficiency of the work done, the adequacy of the service, or the quality of the municipal administration. However, good cost accounting will at least yield unit costs in dollars per cleaning mile. It is true, also, that good administration will result usually in lower unit costs. But a comparison of these costs of two or more cities is practicable only if they are arrived at by identical methods and on identical bases.

Many factors affect the cost of work, such as the cleaning method, condition of the streets, extent of all-night parking, climate, topography and wage rates (which may range from 25 to 75c. per hour). There are other factors which it is difficult or impossible to evaluate. In any one city, however, where the various factors may be constant over a period of time, a comparison of unit costs at different dates within this period will give a measure of the administrative improvement or degeneration. Similar useful comparisons may be made between different districts of the city. In this way, the unit cost figures of a city have great potential usefulness for internal control.

Cleaning catchbasins

The cleaning of catchbasins is another example and a more complex problem of cost accounting. There is a question as to what measuring unit should be adopted; cost per catchbasin or cost per cubic yard of dirt removed. The work will cost more on a catchbasin that is full than on one that is half empty, but how much more? To some extent the amount of work is independent of the amount of dirt handled. The operation consists of the following steps: (1) moving the crew and equipment to the basin, (2) setting up the equipment, (3) removal of the dirt and (4) reassembly of equipment. The cost of the first step is dependent principally upon the distance traveled, and consequently the unit cost should be in dollars per mile. The second and fourth steps involve costs that are practically constant for all catchbasins, so that the unit costs should be in dollars per basin cleaned. As the cost of the third step is governed by the quantity of material, the proper unit of cost is per cubic yard. Thus the component elements of the operation are dependent upon entirely different factors.

Most public-works operations are of this complex kind, and when analyzed into their component elements it is found that the factors governing costs vary with different elements. In street construction, for example: grading cost will depend upon quantity and character of earth moved; cost of paving will depend on design, and on width and length of street paved; curb and gutter installation will be governed by design and length. It is clear that no one single unit would serve all these operations.

What unit to use

Selection of the proper unit is baffling in many operations. How might we measure sewer cleaning, for instance? Actual removal of the clogging material accounts for only a part of the effort involved. Street repair may be measured on a square-yard basis; but area is only one of a host of factors. In refuse collection, the refuse may be a mixture of garbage, rubbish and ashes; or garbage alone; or rubbish and ashes alone, or some other combination. It may be presented for collection loose or paper-wrapped, in barrels or in small containers, or merely as a pile in the alley. It may be picked up from the street curb, the alley gate, the back porch or the basement; and the houses may be close together or far apart. Within any one city many of the factors affecting costs are constant over time and others are constant over districts. Unit costs of complete operations are of value to an administration in exercising internal control and appraising administrative efficiency year by year or district by district. But to use these costs to appraise efficiency in other cities is going beyond the limit of proper or useful application of the unit costs.

What do costs tell?

The cost side of the question also has to be considered. Costs as reported by most cities tell only part of the story. Most of the relatively few cities that determine costs confine their efforts to a computation of labor and materials. A few charge equipment operating costs, but depreciation of equipment is rarely considered, and it is rare indeed for a city to include a proper share of overhead expenses. A uniform and complete method of accounting is indis-

pensable for the determination of unit costs that will have more than local significance. While accounting is expensive, this expense is frequently over-estimated; and for purposes of internal control, extremely useful results can be produced without the elaboration needed for comparisons between cities.

As a conclusion, it may be said that public-works operations are frequently of considerable complexity, and their operating cost is a function of a host of variable factors, of which administrative efficiency is only one. But unit costs founded upon relatively simple measurements of whole operations do provide a useful administrative tool. When used with full knowledge of their inherent limitations, such costs can make an important contribution toward stimulating improvements in administrative efficiency.

Paving Areas at Intersections

VERLIN M. WANN

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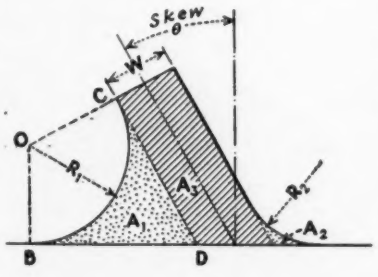
THE ACCOMPANYING TABLE was constructed by the author as a means to facilitate the computation of the pavement area at a skew intersection of two highways. With these tables it is only necessary to know the radii of curvature R_1 and R_2 of the pavement edge at the corners; these radii can be obtained from the curve data or may, as is often done, be arbitrarily assumed.



Skew	k_1	k_2	Tan $\frac{90°+\theta}{2}$	Tan θ
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1	.02483	.02289	1.01761	.01746
2	.02585	.02197	1.03553	.03492
3	.02691	.02108	1.05378	.05241
4	.02801	.02022	1.07237	.06993
5	.02914	.01940	1.09131	.08749
6	.03032	.01860	1.11061	.10510
7	.03153	.01782	1.13029	.12278
8	.03280	.01708	1.15037	.14054
9	.03410	.01636	1.17085	.15838
10	.03545	.01566	1.19175	.17633
11	.03686	.01499	1.21310	.19438
12	.03831	.01434	1.23490	.21256
13	.03981	.01372	1.25717	.23087
14	.04137	.01312	1.27994	.24933
15	.04299	.01254	1.30323	.26795
16	.04467	.01198	1.32704	.28675
17	.04641	.01144	1.35142	.30573
18	.04821	.01091	1.37638	.32492
19	.05008	.01041	1.40195	.34433
20	.05202	.00993	1.42815	.36397
21	.05404	.00946	1.45501	.38386
22	.05614	.00901	1.48256	.40403
23	.05830	.00858	1.51084	.42447
24	.06056	.00816	1.53986	.44523
25	.06290	.00776	1.56969	.46631
26	.06534	.00737	1.60033	.48773
27	.06789	.00700	1.63185	.50953
28	.07050	.00663	1.66428	.53171
29	.07324	.00630	1.69766	.55431
30	.07609	.00597	1.73205	.57735
31	.07906	.00565	1.76749	.60086
32	.08216	.00535	1.80405	.62487
33	.08538	.00506	1.84177	.64941
34	.08874	.00478	1.88073	.67451
35	.09224	.00451	1.92098	.70021
36	.09589	.00424	1.96261	.72654
37	.09971	.00401	2.00560	.75355
38	.10370	.00377	2.05030	.78129
39	.10787	.00355	2.09654	.80978
40	.11223	.00333	2.14451	.83910
41	.11679	.00312	2.19430	.86929
42	.12157	.00293	2.24604	.90040
43	.12658	.00274	2.29984	.93252
44	.13183	.00256	2.35585	.96569
45	.13735	.00239	2.41421	1.00000
46	.14314	.00223	2.47509	1.03553
47	.14923	.00207	2.53865	1.07237
48	.15565	.00193	2.60509	1.11061
49	.16240	.00179	2.67462	1.15037
50	.16953	.00166	2.74748	1.19175
51	.17705	.00153	2.82391	1.23490
52	.18500	.00141	2.90421	1.27994
53	.19342	.00130	2.98868	1.32704
54	.20234	.00119	3.07768	1.37638
55	.21180	.00110	3.17159	1.42815
56	.22186	.00100	3.27085	1.48256
57	.23257	.00091	3.37594	1.53986
58	.24399	.00083	3.48741	1.60033
59	.25617	.00075	3.60588	1.66428
60	.26923	.00068	3.73205	1.73205
61	.28322	.00061	3.86671	1.80405
62	.29826	.00055	4.01078	1.88073
63	.31446	.00049	4.16530	1.96261
64	.33195	.00044	4.33148	2.05030
65	.35090	.00039	4.51071	2.14451
66	.37147	.00035	4.70463	2.24604
67	.39389	.00030	4.91516	2.35585
68	.41842	.00026	5.14455	2.47509
69	.44533	.00023	5.39552	2.60509
70	.47500	.00020	5.67128	2.74748
71	.50786	.00017	5.97576	2.90421
72	.54445	.00014	6.31375	3.07768
73	.58541	.00012	6.69116	3.27085
74	.63158	.00010	7.11537	3.48741
75	.68398	.00008	7.59575	3.73205

Skew	k_1	k_2	Tan $\frac{90°+\theta}{2}$	Tan θ

As can be seen in the accompanying figure, the area desired can be divided into three parts.

Area A_1, and likewise A_2, are directly proportional to the square of the radius of curvature.

$$CD = R_1 \tan\left(\frac{90° + \theta}{2}\right)$$

and area

$$DCDB = R_1^2 \tan\left(\frac{90° + \theta}{2}\right)$$

hence area

$$A_1 = R_1^2 \tan\left(\frac{90° + \theta}{2}\right) - \frac{\pi R_1^2 (90° + \theta)}{360}$$

or $$A_1 = R_1^2 k_1$$

and $$A_2 = R_2^2 k_2$$

Area A_3 is given by the formula

$$A_3 = \frac{W}{9}\left[R_1 \tan\left(\frac{90° + \theta}{2}\right) + \frac{W}{2}\tan\theta\right]$$

The values of k_1 and k_2 have been computed in the accompanying table for values of the skew angle from 0 to 75 deg. For convenience in computation values of the trigonometric quantities have been included.

The values of the constants are so computed that if the road width W and the radii of curvature R are in feet, the areas A will be obtained in square yards. This will aid in preparing cost estimates.

• • •

Rail Welding In Australia

Welding rails into long lengths has been practiced since 1933 by the government railways of New South Wales, and by June 30, 1939, there was a total of 297 mi. of welded track. Until December, 1938, the thermit process was used, but a flash butt-welding plant has been established and "in consequence of the greater economy derived from its use, thermit welding will be confined to work on the track at particular localities."

At the welding plant the rails are welded into lengths of 360 ft. and loaded on special flat cars. With 300 welds per week on 107-lb. rails, the cost per weld is about $2. More than 54 miles of welded track were laid in 1938-39, of which 37 miles were by the thermit process. Two of these lengths are continuous for 3 mi. and there are other lengths of 1 to 2 mi. each.

Bidding Practice Two Centuries Ago

RICHARD SHELTON KIRBY

Chairman, Department of Engineering Drawing
Yale University, New Haven, Conn.

Contents in Brief—An old book throws light on the bidding practice of 1729. Extracts from it show many contract clauses reminiscent of today's engineering specifications. An interesting feature is the advice to the engineer that the contractor is justified in expecting to make some money. Skimped work brought fines and jail sentences.

THE FIRST modern civil engineering textbook was, I believe, Belidor's "*La Science des Ingénieurs,*" written in 1729. It is not quite a pocketbook, nor even a handbook, for our copy weighs five pounds and has the proportions of a family Bible. In his dedication of the book to Louis XV, the nineteen-year-old King of France, Belidor, I suppose with his tongue in his cheek, expressed the hope that the publication would be an important enough achievement to warrant his "arriving some day up to the foot of His Majesty's throne."

There are 504 pages in the work, devoted to such subjects as the theory of arches, masonry construction, fortresses and civil architecture. Vauban is often quoted throughout, for the author evidently made use of some of his memoranda. The great military engineer died when Belidor was a child.

The last section, of eighty pages, is headed "The Manner of Making the Specifications." From it I have translated below, rather freely and with some condensation, the greater part of the little chapter that deals with the formalities to be observed in the letting of government work, especially fortress construction.

Bertrand Forest de Belidor (1697-1761), engineer, architect and author in the time of Louis XV of France; famous for his treatise "Architecture Hydraulique" but also the author of the earlier book on civil engineering that is interestingly quoted in this article.

The specifications having been prepared and a part of the funds provided, the official of the province causes to be published and posted in all towns in his department, and even in neighboring provinces, that on a certain day he will proceed to his mansion, where in his presence the arrangements will be made for work to be done in the construction of a new fortress, and where he will meet all those who wish to undertake this enterprise and to contract with his Royal Highness, giving good and sufficient surety.

When the day arrives, the official, accompanied by the director of fortifications and others concerned with the project, will cause the entire specifications to be read in a loud voice, in order that prospective bidders for the said enterprise may be informed as to the nature of the work to be constructed and the conditions to which they must adjust themselves. After this will commence the bidding of the contractors for each class of work. When it happens that no one submits a low enough bid, three wax candles in succession are lit, and until the last one has burned out a new contractor will still be permitted to proffer a bid. Finally, after the candles have burned out, the project is awarded to whomsoever has made the bid that is most advantageous for the King, and a procès-verbal is drawn up somewhat in the following terms.

"Today this ..... month ..... year and ..... day, We ..... (names and titles of the officer of the province) being at our mansion at .... (name of town), after several advertisements and publications having been duly made in said town as well as in other towns of the province .... to the effect that on the said day we would proceed to arrange for bids for work which the King has ordered to be done in the construction of a new fortress at .... according to the design of .... (the engineer) .... have proceeded in the presence and according to the advice of M...., chief engineer of fortifications of the said town to the clauses and conditions the tenor of which follows:"

Clauses and conditions

Here are copied the entire specifications in the form prescribed, and after this the procès-verbal is continued in the following manner:

The contractors accept the conditions of the present specifications: they will furnish all materials, and will be responsible for securing laborers, wagons, scaffolding, bridges, lumber, tools, machines, ropes, and in general all things necessary to the conduct of their enterprise; also at their own expense will provide for all pumping of water; and will be obligated one year after the construction of the fortress to point up all masonry joints with good mortar of lime and sand, without any claim on His Majesty for extra compensation beyond the price named. We understand that no earth is to be measured twice even though it is necessary to handle some of it a second time, excepting that which has been screened, and any top soil that has been laid aside to form parapets, which will be counted as having been handled twice. It will be further noted that no embankment will be measured in nor any voids in the mass of masonry. In addition the work will

be carried on with all possible diligence, subject to verifications and acceptances in the usual manner, and will be guaranteed for one year after it has been accepted by the engineers in charge.

In return the contractors will be exempt from guard duty, from all corvée duty and from being required to lodge soldiers; and they will be allowed to cut all the grass they need, in the fields or old pastures nearest at hand which will be designated by our assistant or by the magistrates of the town and the chief engineer of the fortifications, without the said contractors being obliged to pay anything to the owners of the land.

If the fortress is on the frontier and a war is on, it should be added that necessary escorts will be given the contractor for the protection of his animals, be they horses or oxen, employed to transport material for the work. In case the said horses or oxen are taken, with their escorts, by any enemy party of either regular or irregular troops, while they are hauling the materials, the contractor will be indemnified for their fair value. In case the said contractor or his agents are taken prisoners by the enemy while in the King's service, their ransom will be paid by his Majesty. [This paragraph is in Italics—R.S.K.]

And after the reading of the above specifications in a loud and intelligible voice, and after the said contractors assembled for bidding have said that they understood them, the said work has been bid for at the following unit prices, namely:

Here follows the form for recording the names of the bidders and the sums named by them as their bid prices. Masonry and earthwork are bid in prices per cubic toise, a toise being about 6.4 ft.

And thus is to be designated each different class of work, without forgetting any, if it is possible, in order to prevent all arguments in future, and specifying for each article all the bids that have been made, in proper order and finishing with the last and lowest bid.

After which we have lighted three candles in succession, to see if while they were burning some one of the assembled persons would not make a new bid. But, the said flames having extinguished themselves, and we having made three other attempts on different days, without anyone appearing who wished to undertake the said work at a lower price nor under conditions more advantageous to the King than M....., We, on the advice of M....., the director, and under the good pleasure of His Majesty, have awarded and do award the said work, to him, expecting him to give good and sufficient surety.

Here follows the name of the successful bidder and his bid price for each class of work—earthwork, masonry, etc.

The said prices will be paid to the said contractor in the King's money out of funds provided and to be provided in proportion as the work advances, and on certificates of the principal engineer in charge.

Done on the day and year above mentioned, signed by the official, the director and the contractor.

And at the same time the said M..... .....has offered to us as surety the person of William ....., residing at ....., to the end that in this capacity of associate he is obligated and by these presents does obligate himself securely in terms of money and business of His Majesty and by the same agreements by which the said contractor is held.

Advice to engineers

For the control that engineers ought to have over contractors it is necessary at the outset to be convinced that, since undertakings are carried on for profit only, an engineer should devote his full attention to seeing to it that this profit motive does not result in poor workmanship or in neglect. To prevent this the engineer must spare neither care nor pains to see that all things are done in order, and to be always present, as far as possible, when any work is being done. The masonry especially demands his actual presence, as much for the preparation of the mortar as for the selection of stones to be used; he must not be so indulgent in these matters that the workmen become careless. It is his duty to be regular in his accounting and prompt in his estimates, in the furnishing of lines and grades, and in the acceptance of materials. He must not forget to fix the size of timbers before the work is complete for fear that the contractor, abusing the leniency that has been shown him, will multiply unduly the number of hundreds of joists. This abuse is not the less serious and is often more harmful to the work than that of using too weak timbers. The same is true of iron connections and of many other details which it would take too long to enumerate.

Contractors entitled to profit

On the other hand it is not necessary to be uneasy nor go into excessive refinements. The good of the service demands that the contractor carry on, and that he spare nothing for the betterment of the work. But it demands also that the contractor make a profit to pay him for his labor and expense. If, however, he has made a bad bargain, or if troublesome or inevitable difficulties arise, it is not for the engineer to interfere, for the contractor may take the matter to the King's Court, as is often done; and when his plea is well founded he is assured of finding indemnity for his losses in the bounty of the King. But he should not take unimportant matters to this tribunal. An engineer who knows his duties will easily see how to do that which is just and fair, and when he takes a little pains to enter into the details of each case he can tell at a glance what ought to be done.

The section closes with a modern-sounding discussion as to the comparative advantages of letting work to a single general contractor, or partitioning it out among several with the argument in favor of the former arrangement.

It might be added that bargaining by "inch of candle" seems to have been an old French custom which had found its way into England long before Belidor's day. Pepys refers to it in his diary a number of times in speaking of buying naval supplies. American contractors and engineers will recognize, throughout the specifications, phrases which still persist in our contract documents.

Belidor's other works

Bernard Forest de Belidor was only thirty-four when he wrote his book. The *Department des Ponts et Chaussées* had been organized thirty years earlier, while the *Ecole des Ponts et Chaussées* was not to be fully formed until 1760. Belidor later wrote a second book, the more important "Architecture Hydraulique," a three-volume work that was considered authoritative even outside of France well into the 19th century. In this latter work Belidor quotes Vauban's specifications used in 1684 for the locks at Dunkerque harbor. One sentence from this elaborate document of two centuries and a half ago will bear quoting. "And if any of the masons be found laying up masonry dry and without mortar he will be driven from the work and thrown into jail and the contractor will be compelled to pay a fine of 100 francs."

. . .

Progress on Foundations For Cleveland Bridges

Twenty-four of the thirty-six foundation shafts for the tower piers of the three new lift bridges being built over the Cuyahoga River in Cleveland (*ENR*, Oct. 26, 1939, p. 541) have been completed to date. The material passed through comprised soft clay, quicksand, gravel and hardpan, with final socketing in hard shale; heavy flows of water were encountered at times and at a few points natural gas. George B. Sowers, consulting engineer of the city of Cleveland, reports that all shafts put down are straight and true and were completed without accident. Each shaft and rock socket was inspected by one or more engineers before concreting.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

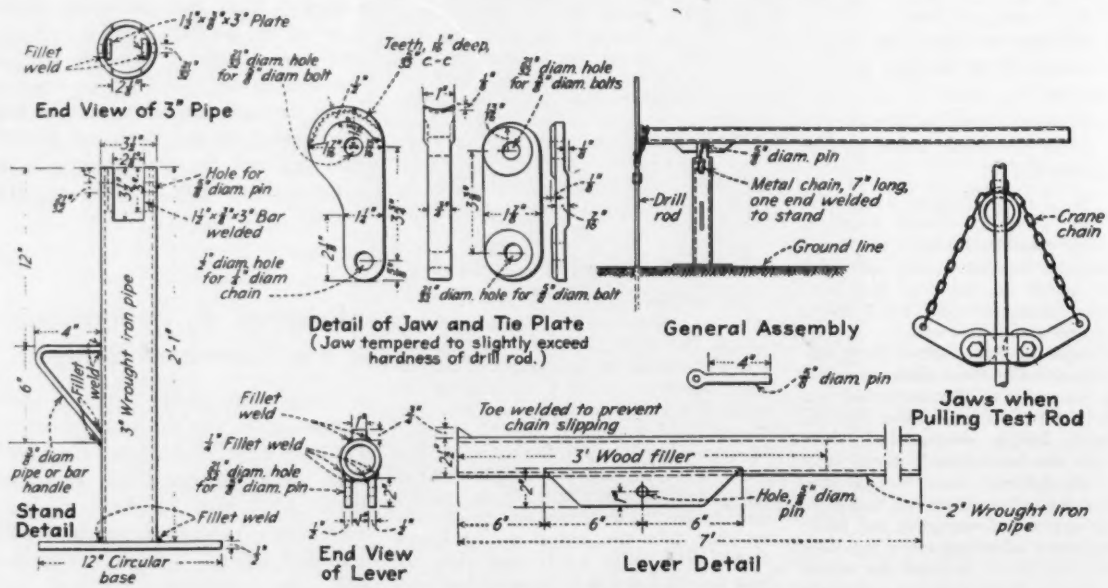
Form Assembly Building

C. E. BLEE
Project Engineer, Hiwassee Dam, N. C.

To provide a working space big enough for the construction of the entire draft tube form, without undue exposure to the elements, the TVA's construction forces at Hiwassee Dam built a covered erection platform adjoining the carpenter shop, measuring 78x45 ft. in plan, with a 35-ft. clear height to the bottom chords of the roof trusses. Although the plan of construction for the draft tube form was later revised so that it was not shop-assembled in its entirety, the covered erection platform has made possible the construction of a number of form units of unusual size.

The sheet-metal roof is supported by combination steel and timber trusses on timber columns. I-beam trolley rails are bolted to the bottom chord of the trusses 12 ft. on each side of the centerline of the platform, to carry two 5-ton electric traveling hoists with individual control so that they can be used jointly or separately. The columns and girders have been extended three bays (about 50 ft.) beyond the end of the erection platform to support the trolley rails, thus permitting completed forms to be loaded directly onto trucks by the electric hoists, and also providing a small storage yard for form units which are completed before they are needed in the

Form assembly building at Hiwassee Dam. Hoist trolleys extend to right.


End View of 3" Pipe
Detail of Jaw and Tie Plate
(Jaw tempered to slightly exceed hardness of drill rod.)
General Assembly
Jaws when Pulling Test Rod
Stand Detail
End View of Lever
Lever Detail
3" Wrought iron pipe
12" Circular base
3" Wood filler
2" Wrought iron pipe
Drill rod
Metal chain, 7" long, one end welded to stand
Ground line
Crane chain
Toe welded to prevent chain slipping
Fillet weld
Hole for ⅜" diam. pin
Hole, ⅜" diam. pin

WORKING DRAWINGS FOR A SOUNDING ROD PULLER

Sounding rod tests of subsoil conditions in planning small bridge foundations involve a nice problem in designing hand equipment that is within the means of small truck transportation of outfit and crew. The elements of the outfit, both for driving and pulling the sounding rods, must be such that they can be assembled, taken apart and loaded by hand and, when assembled for work, hand operation must be practicable. One of the most difficult operations often is pulling the rod after the sounding is completed, and in designing its new equipment the bridge division of the Pennsylvania highway department gave particular attention to a light and powerful hand-operated rod puller. In general principle this puller is not different from others; its interest is in the working drawings which enable the puller to be reproduced in all the details found essential by field experience. Incidentally, the sounding outfit of which the puller shown is a part was adopted in sounding for the structures on the 161-mi. Pennsylvania Turnpike now under construction. We are indebted for the drawings given here to E. E. Brandow, bridge engineer, Pennsylvania department of highways.

dam. The trolley rails are joined at the outer end by a semicircular curve so that both hoists can be used on the same side of the platform if desired.

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Correction Note

The name of the author of the article entitled "Progress Chart for P.W.A." published in these pages in the September 28 issue, is H. P. Hoskins, not Hopkins, as given in that item.

. . .

Lowering a Water Main

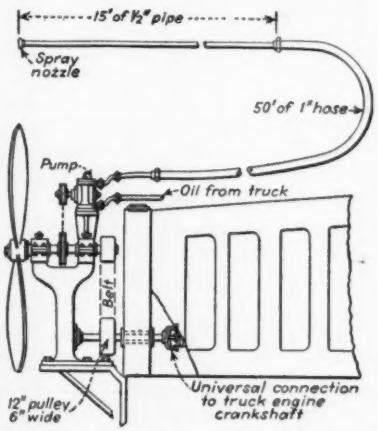
JOHN E. FAIGLE
Lieutenant, Civil Engineering Corps
U. S. Navy, Guantanamo Bay, Cuba

During 1912, at the United States Naval Station, Guantanamo Bay, Cuba, a fresh water main was laid on the surface of the ground. In connection with a rehabilitation of the grounds at the station it was necessary that the water main be placed underground to improve appearances and to protect the pipe. The problem was to do the job cheaply, using only native labor and simple tools, and at the same time give uninterrupted service. Ten laborers excavated a trench to proper depth directly below the pipe, leaving the pipe supported near the joint by a series of unexcavated earth saddles, one to each section of the pipe. A portion of the excavated earth was then placed under the mid-point of each section of pipe and the unexcavated supports were removed. This soft earth which then supported the pipe was slowly removed by stages throughout the full length of the line which left the pipe lying in the desired position as the last of the soft earth was removed. The trench was then backfilled.

. . .

Torch for Burning Green Timber

Fast burning of green brush, logs and stumps collected in clearing the right-of-way for the east approach to the Lake Washington pontoon bridge was accomplished with the oil-torch illustrated. The cuttings consisted of green and wet brush, logs up to 2½ ft. in diameter and stumps, all pushed together, with more or less earth, by bulldozers. The rig made use of a fan consisting of an airplane propeller 5½ ft. in diameter on the shaft of an old emery-wheel stand mounted on the front end of an oil truck. The fan was driven at 2,000 rpm by a belt from an extension of the main shaft of the truck motor. From the same motive power a small pulley drove a geared oil pump that could develop a pressure of about 100 lb. per sq.in. By this pump oil was drawn from the supply tank on the truck and forced through 50 ft. of hose to a spray nozzle placed near the pile of debris to be burned. A length of pipe at the nozzles kept the hose well back from the fire.



Elevation showing arrangement of fan and oil pump on front end of the motor truck.

To start operation, a small fire was kindled on the near side of the pile of debris, fan and oil spray were then started and the strong draft carried the fuel into the burning mass. The combination functioned much as an enormous blow torch and, with 10 to 15 gal. of burner oil per hour, maintained a continuous fire so hot that even the wettest masses burned very speedily. The fan created a wind estimated at 30 mph at medium engine speed which could be increased to about 45 mph at full throttle. The width of the air blast was about 14 ft. The device was constructed and operated by C. A. Nelson, Bellevue, Wash.

Method of lowering a surface water main by progressive excavation.

CAMERA MEMORANDUM

Trailer for diver's equipment inside and ladder rack on top. Hydraulically operated landing wheels under the draw-bar permit easy coupling and handling of trailer. In the box above the drawbar are three kerosene torch pots. The black bridge-barrier markings on a yellow background and a center bar in the rear window of his car give the driver a cross-hair-like gage on the behavior of trailer and load at high speed as this is particularly an outfit for emergency work.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Construction Materials

JOHNSON'S MATERIALS OF CONSTRUCTION—By the late J. B. Johnson. Eighth edition rewritten by M. O. Withey and James Aston. 867 pp. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London. Price $6.

MATERIALS OF CONSTRUCTION—By the late Adelbert P. Mills. Fifth Edition, rewritten and revised by Lloyd F. Rader. 564 pp. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London. Price $4.

ENGINEERING MATERIALS—By Alfred H. White. 547 pp. Published by the McGraw-Hill Book Co., Inc., New York and London. Price $4.50.

Three books on construction materials have just been published. Two are new editions of well-known books and the third is a new book. Of the older books appearing in revised form, "Johnson's Materials of Construction" is the most comprehensive. It is now in its eighth edition, which includes revisions of the chapters on wood, on cements and on methods of testing. The chapter on fatigue has been rewritten and a new chapter on metals for light-weight construction has been added. Newer materials such as asbestos-cement pipe do not appear, and despite the size of this text there is nothing on such important materials from the civil engineer's viewpoint as asphalts, bituminous paving materials and cast iron or steel pipe.

Mill's "Materials of Construction" is a smaller and much more general text. About half of the present revised book is given over to the manufacture of ferrous metals and to non-ferrous metals and alloys. The sections on cement and concrete have been rewritten and a new section on bituminous materials has been added.

White's "Engineering Materials" is a new book. The author has one major advantage over the men who undertook to revise the older texts in that he starts with a clean sheet and with no text or cuts standing which must be salvaged if possible. The effect is a thoroughly modern treatment. The book has been prepared for the use of students. The treatment is general enough so that the student should get a proper understanding of the properties and uses of engineering materials without being confused by too much detail that is of value chiefly to the specialist. An interesting variation from current practice with such texts is inclusion of a section on fuels and combustion and one on water and its industrial utilization.

Fort Peck Slide Data

REPORT ON THE SLIDE OF A PORTION OF THE UPSTREAM FACE OF THE FORT PECK DAM—Prepared and published by War Department, Corps of Engineers, U. S. Army, Washington, D. C. Price $6.

A slide involving over 5,000,000 cu.yd. of fill occurred in the upstream face of Fort Peck Dam on Sept. 22, 1938. Immediately thereafter an investigating board was set up and in May of this year the board submitted to the Chief of Engineers a brief report as to the cause of failure and as to remedial measures to be taken. Accompanying the report were two minority reports. For obvious reasons, the mass of information on which the board members based their conclusions could not be made public along with the statements from the board, hence the engineering profession had no way in which to evaluate the divergent views expressed by the board members. The majority placed responsibility for the slide on a foundation failure, while the late Thaddeus Merriman, in his dissenting statement, placed responsibility directly on the decomposed shale of the east abutment and indirectly on the speed with which the dam had been built.

Now the Corps of Engineers has published in book form much of the data collected by it for the board. These data are presented largely in diagrammatic form. Of special interest are the diagrams showing the large amount of foundation subsidence that has occurred, also the record of the 36-in. cores taken by calyx drills from frozen zones in the slide area. The cores taken from deep in the underlying material show how it was involved in the slide.

The record that the army engineers here make available to those interested in earth-dam design and construction calls for careful study in order that the lessons of this slide may be fully appreciated.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

THE DROUGHT OF 1936, with discussion of the significance of drought in relation to climate, is the subject of U. S. Geological Paper 820. Obtainable from the Supt. of Documents, Washington. Price 15c.

SOIL-CEMENT ROADS is the subject of a new pamphlet put out by the Portland Cement Association, 33 West Grand Ave., Chicago. The pamphlet gives methods for sampling and testing soils as well as construction methods for the building and maintenance of soil-cement roads. Included are specifications for soil-cement roads and cost data.

THREE DAMS of the Tennessee Valley Authority are described in illustrated monographs put out by the authority. Technical Monograph No. 34 deals with Norris Dam, No. 41 with Pickwick Landing, and No. 42 with Wheeler Dam. Each is illustrated with over 100 drawings. The books may be obtained from the Information Office, Tennessee Valley Authority, Knoxville, Tenn. Price $2.50 each.

NEW ENGINEERING BOOKS

RURAL WATER SUPPLY AND SANITATION—By Forrest B. Wright. 288 pp. Published by John Wiley & Sons, Inc., New York City; Chapman & Hall, Ltd., London. Price $2.50.

ELEMENTARY DESIGN OF STRUCTURAL STEEL AND REINFORCED CONCRETE—By Charles Kandall. Second Edition. 163 pp. Published by Federation Technical School, 116 E. 16th St., New York City. Price $2.

INFLUENCE LINES—By David S. Stewart. 215 pp. Published by Constable & Co., Ltd., London. Obtainable from The Engineers Book Shop, 168 E. 46 St., New York. Price $4.50.

(*Continued on p.* 78)

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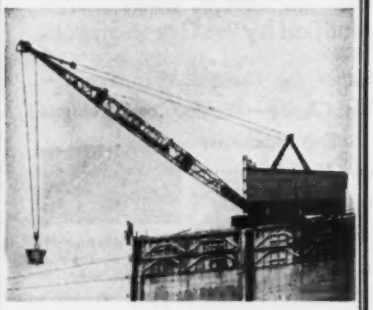

- Gear swing type.
- Booms up to 150 feet.
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- Actual capacities up to 30 tons.

★

Wiley Concrete Buckets

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WILEY EQUIPMENT

Port Deposit, Md. Lancaster, Pa.

NEW ENGINEERING BOOKS

(Continued from p. 76)

REGIONAL PLANNING PART VIII—NORTHERN LAKE STATES. Report to the National Resources Committee. 63 pp. For sale by Superintendent of Documents, Washington, D. C. Price 25c.

THE STRUCTURE OF THE AMERICAN ECONOMY—Part I—Basic Characteristics. Report to National Resources Committee. 396 pp. For sale by Superintendent of Documents, Washington, D. C. Price $1.

REPORTS AND PAMPHLETS

LAND SUBDIVISION—Manual No. 16, American Society of Cicil Engineers, 33 West 39th St., New York City. Price 60c, members; $1.20, non-members.

URBAN AND SUBURBAN RAILWAYS—By Paul H. Bendtsen. May be obtained from the Denmark Technical Highschool, Kobenhavn, Denmark. Price, Kr. 8,00.

REPORT ON TRAFFIC AND SAFETY, Grand Rapids, Mich.—By Jensen, Bowen & Farrell, Ann Arbor, Mich. May be obtained from the Grand Rapids Association of Insurance Agents, Grand Rapids, Mich. Price $5.

MANHATTAN 1938-1939—A Report by Stanley M. Isaacs, Borough President, Municipal Bldg., New York City.

THE CONNECTICUT SOCIETY OF CIVIL ENGINEERS, INC.—Report for year ending March, 1939, New Haven, Conn.

NEW JERSEY—61st Annual Report of the Department of Health, Trenton, N. J.

FATIGUE TESTS OF CONNECTION ANGLES—Bulletin No. 317, Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 30c.

THE EFFECT OF RANGE OF STRESS ON THE TORSIONAL FATIGUE STRENGTH OF STEEL—Bulletin No. 316, Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 45c.

THE SOLUBILITY OF CEMENTS—Technical Paper No. 26, Department of Scientific and Industrial Research, London. May be obtained from British Library of Information, 50 Rockefeller Plaza, New York City. Price 15c.

SINGAPORE—Annual Report of the Water Department and Annual Report of the Engineer's Department for 1938. Published by the Municipal Commission, Singapore.

EGYPT—Annual Report for the year 1931-32. Part II. May be obtained from Publication Office, Government Press, Bulaq, Cairo. Price P.T. 100. Annual Report for the year 1932-33. Part I. Price P.T. 50.

RAINFALL AND DISCHARGE RECORDS FOR NORTHERN IOWA DRAINAGE DISTRICTS—72 pp. Bulletin No. 141, Iowa State College, Ames, Iowa.

THE METHOD FOR THE MECHANICAL TESTING OF CEMENTS adopted by the new Brazilian specifications—By Ary F. Torres. May be obtained from Institute for Technological Research of Sao Paulo, Sao Paulo, Brazil.

RESISTANCE MECANIQUE DES CONDUCTEURS AERIENS—By Pierre Devedec. 62 pp. Published by Alliance Graphique, 64, Chaussee de Mons, Brussels. Price 2.30 Belga.

EL FUTURO PLAN DE OBRAS PUBLICAS DEL ESTADO ESPANOL (No. 2)—May be obtained from Ministerio de Obras Publicas, Madrid, Spain.

FLOOD DISCHARGE RECORDS RELATING TO PENNSYLVANIA STREAMS—Dept. of Forests and Waters, Division of Hydrography, Harrisburgh, Pa.

NAVIGATION ON THE MONONGAHELA AND ALLEGHENY RIVERS—Compiled by Corps of Engineers, U. S. Army, Pittsburgh, Pa.

29th BIENNIAL REPORT of the State Engineer to the Governor of Colorado—1937-38. 460 pp. M. C. Hinderlider, State Engineer, Denver, Colo.

KANSAS CITY, MO.—Annual Report of the Water Department. 1938.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.—Annual Report for year ending Sept. 1939. May be obtained from Institute, 101 Park Ave., New York City.

DUBUQUE, IOWA—39th Annual Report of the Water Department. March 1939.

PROCEEDINGS TWELFTH NATIONAL ASPHALT CONFERENCE—1939. 256 pp. The Asphalt Institute, 801 Second Ave., New York.

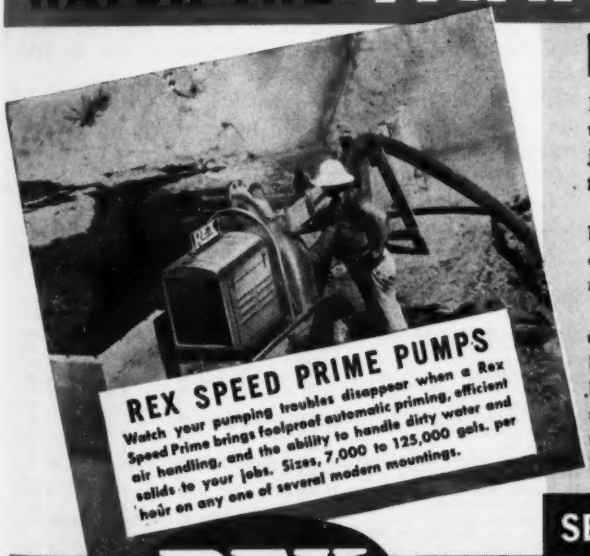
PROCEEDINGS OF 13TH ANNUAL CONFERENCE, Maryland-Delaware Water and Sewerage Association, 2411 N. Charles St., Baltimore, Md.

YOUR CITY GOVERNMENT—Vol. 2, Council Proceedings and Reports, Schenectady, N. Y. 1938. May be obtained from the City Manager.

NATIONAL CONFERENCE ON PLANNING—Proceedings of the 1939 conference. 166 pp. Published by the American Society of Planning Officials, 1313 East 60th St., Chicago. Price $2.

NEW YORK CITY HOUSING AUTHORITY—Fifth Annual Report. 1938. May be obtained from New York City Housing Authority, 122 East 42nd Street, New York City.

WATCH THE WINNING BIDDER



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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

UNDERPASS, MICHIGAN

OWNER: Michigan State Highway Department, Lansing. M. D. Van Wagoner, Commissioner.

PROJECT: Underpass on State Fair Avenue at Grand Trunk Western Railroad, Detroit, Wayne County, Mich. Grade separation underpass involves construction of four ballast deck semi-through plate girder span 51-ft. 8-in. long over roadway, and 13-ft. 3-in. over sidewalk sections. Supported by reinforced concrete combination abutments and sidewalk bents. Intersection angle between tracks and street is 59-deg. 38-min. 40-ft. clear roadway, and two 9-ft. sidewalks.

CONDITIONS: Project being constructed by State Highway Department in accordance with City-State agreement. Pedestrian overpass to be maintained during construction. Contractor to furnish all materials and complete project by June 1, 1940. Rail and highway transportation available. Wage rates specified are: skilled, $1.50 per hr.; semi-skilled, 85c. per hr.; and common, 70c. per hr.

BIDS: Seven bids received Sept. 27, 1939, ranging from the contract low of $102,303 to $116,836.

LOW BIDDERS:

1. Bryant & Detwiler Co., Detroit, Mich.....$102,303
2. W. J. Storen Co., Detroit, Mich..... 104,190
3. Walbridge Aldinger Co., Detroit, Mich..... 106,459

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Found. excav., uncl.	2,515 c. y.	$1.50	$1.80	$2.00
2. Conc., Grade A, substr.	1,373 c. y.	15.00	13.00	14.00
3. Conc., Grade A, superstr.	209 c. y.	20.00	22.00	20.00
4. Conc., Grade A, crib wall ftgs.	61 c. y.	15.00	13.00	20.00
5. Cement	2,452 bbl.	1.60	1.75	2.10
6. Reinforcing steel	154,642 lb.	.04	.035	.04
7. Struct. steel, fabr., erect.	457,680 lb.	.06	.06	.0575
8. Railing	153 l. f.	9.00	7.50	7.50
9. Field painting, str. steel	L.S.	735.00	1,000.00	750.00
10. Rubbed surf. finish	8,035 s. f.	.15	.10	.10
11. Copper	485 lb.	.80	.50	.40
12. ½-in. joint filler, cork	60 s. f.	.50	.40	.50
13. Waterprfg. back of walls and abut.	4,340 s. f.	.04	.05	.05
14. Bridge deck waterproofing	4,600 s. f.	.10	.10	.10
15. Asph. mastic protect. crse.	2,700 s. f.	.28	.35	.33
16. Mastic comp. surfacing	1,750 s. f.	.13	.22	.20
17. Bitum. calk, girder flanges	L.S.	60.00	100.00	75.00
18. 8-in. corr. met. pipe	110 l. f.	1.25	1.20	1.00
19. 8-in. corr. met. pipe, perf.	385 l. f.	1.25	1.20	1.20
20. Concrete crib walls	8,025 s. f.	1.80	1.80	2.00
21. 8-in. sewer	58 l. f.	2.00	1.50	1.00
22. Heat and house concrete	1,261 c. y.	2.50	2.50	2.50
23. Earth excavation	19,564 c. y.	.45	.67	.60
24. Sodding	900 s. y.	.25	.27	.25
25. Relocate existing fence	3,310 l. f.	.65	.60	.65
26. Constr. 6-ft. chain-link fence	70 l. f.	1.25	1.50	1.25
27. Constr. 7-ft. chain-link fence	110 l. f.	1.40	2.00	1.40
28. Furn. and place gate	1 ea.	150.00	103.00	140.00

HIGHWAYS, NORTH CAROLINA

OWNER: North Carolina State Highway and Public Works Commission, Raleigh. W. V. Baise, Raleigh, State Highway Engineer.

PROJECT: Required structures on 8.31 miles of highway between Yadkin River Bridge and Lexington, N. Car.

CONDITIONS: Project to be completed in 120 working days. Highway transportation available. Labor rates: skilled, 55c. per hr.; semi-skilled, 35c. per hr.; and common labor, 25c per hr.

BIDS: Four bids were opened August 23, 1939, ranging from the contract low of $52,829 to $62,921.

LOW BIDDERS:

1. D. M. Rickenbaker, Union, S. Car. (contract) $52,829
2. Gregory & Poole, Raleigh, N. Car..... 54,618
3. Blythe Bros. Co., Charlotte, N. Car..... 59,165

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Dry excavation	320 c. y.	$1.00	$0.50	$0.75
2. Wet excavation	570 c. y.	3.00	2.00	1.50
3. Uncl. struct. excav.	3,590 c. y.	.75	.35	1.20
4. Channel excavation	100 c. y.	.50	.40	2.00
5. Class A concrete	1,809 c. y.	18.00	21.00	21.00
6. Reinforcing steel	330,870 lb.	.04	.037	.04
7. Untr. timber piles	3,080 l. f.	.75	.60	.70
8. Untr. timber sheet piles	5.9 Mbm.	40.00	40.00	60.00
9. Waterproofing, method A	76 s. y.	1.50	1.00	3.00

CHANNEL IMPROVEMENTS, PENNSYLVANIA

OWNER: U. S. Engineer Office, Pittsburgh, Pa.

PROJECT: Improving channel of Conemaugh, Little Conemaugh Rivers, and Stony Creek (Third Unit), located in Johnstown, Pa., and vicinity. Involves widening, deepening and realigning chanels of rivers and creek; pavement and wall protection of banks of improved channel; alterations to existing pipe outlets; relocation of sewer siphon; relocation of cast iron water pipe lines; protection of existing bridge piers; remodel Minersville pumping station and add new bay.

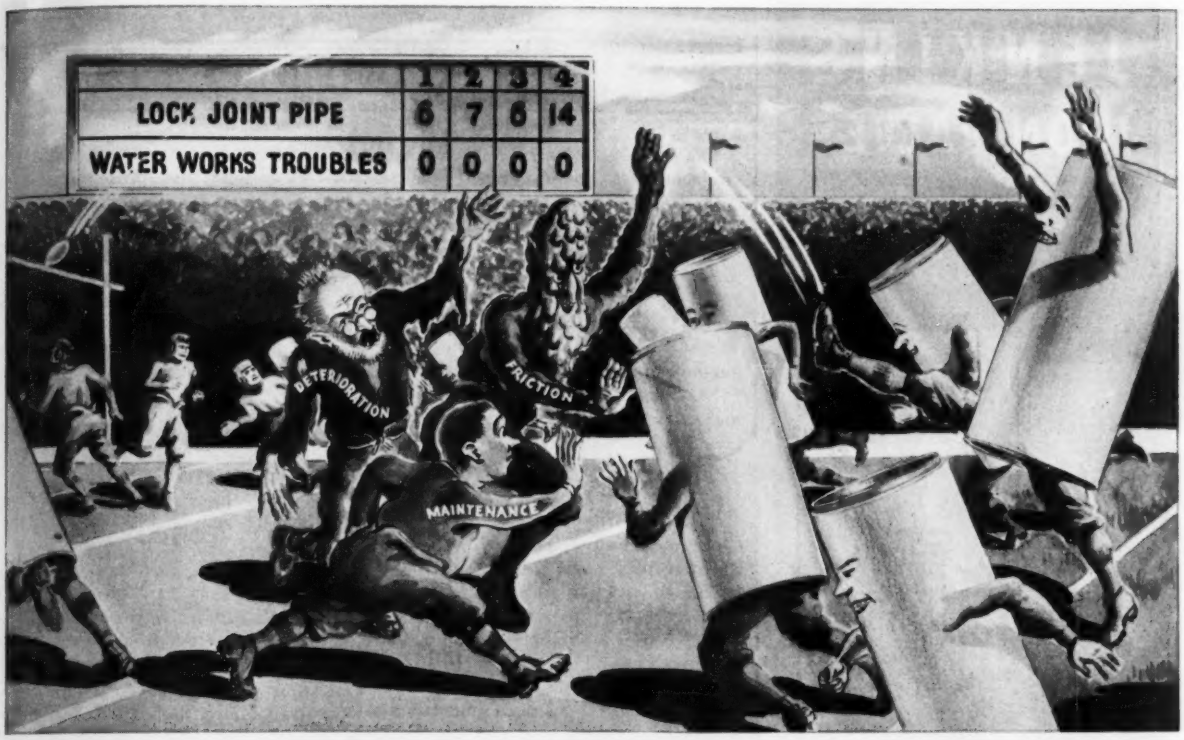
CONDITIONS: All materials in good condition salvaged from pumping station and water pipe lines may be re-used. Work to be completed in 300 calendar days after notice to proceed. Pennsylvania, and Baltimore & Ohio, and privately owned railroad systems, as well as streets in Johnstown available for transportation of material and equipment. Materials to be furnished by contractor. Minimum wage rates specified are: skilled, $1.30 to $1.40 per hr.; semi-skilled, 75c to $1.00 per hr.; and common, 65c. to 70c. per hr.

BIDS: Six bids were received Sept. 11, 1939, ranging from the contract low of $1,314,437 to $1,845,446. Engineer's estimate $1,437,055.

LOW BIDDERS:

1. E. J. Albrecht Co., Chicago, Ill. (contract) $1,314,437
2. Al Johnson Constr. Co., Minneapolis, Minn. 1,494,805
3. Harrison Constr. Co., Pittsburgh, Pa..... 1,551,202

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Remove existing struct.	L. S.	$3,000.00	$7,000.00	$15,200.00
2. Common excavation	660,000 c. y.	.66	.62	.90
3. Rock excavation	23,000 c. y.	1.40	2.50	1.50
4. Special excavation	35,000 c. y.	1.25	2.00	2.00
5. Spec. rock excavation	6,300 c. y.	7.00	8.50	10.00
6. Uncompacted fill	800 c. y.	.10	.20	.10
7. Compacted fill	34,000 c. y.	.25	.50	.20
8. Gravel backing	13,200 c. y.	2.75	3.00	2.85
9. Rock fill	6,000 c. y.	.75	1.50	1.50
10. Concrete	31,500 c. y.	10.50	13.00	11.00
11. Fur. and place reinf. steel	1,810,000 lb.	.04	.045	.042
12. Furnish cement	40,000 bbl.	2.00	3.00	2.60
13. Copper water stops	50 lb.	1.00	2.00	1.00
14. Relocate sewer siphon	L. S.	34,260.00	40,000.00	23,000.00
15. 33-in. vitr. tile pipe or rein. conc. pipe	980 l. f.	10.00	14.00	6.00
16. 36-in. vitr. tile pipe or rein. conc. pipe	450 l. f.	11.00	14.50	7.50
17. Alter exist culv. and drains.	L. S.	15,000.00	10,000.00	13,000.00
18. Fur. and install flap valves	5 ea.	20.00	40.00	35.00
19. Drill 2 and 3-in. holes	590 l. f.	1.75	3.00	2.00
20. Black steel pipe	520 lb.	.20	.80	.11
21. Grouting	1,800 c. f.	2.00	1.30	1.00
22. Fur, new c. i. pipe, fit., specs.	1,543,000 lb.	.04	.035	.04
23. Inst. 12-in. c. i. pipe	240 l. f.	15.00	15.00	12.00
24. Inst. 24-in. c. i. pipe	330 l. f.	20.00	16.00	20.00
25. Inst. 36-in. c. i. pipe	2,665 l. f.	8.00	10.00	9.00
26. Remove 12-in. c. i. pipe	240 l. f.	5.00	1.50	2.00
27. Remove 24-in. c. i. pipe	250 l. f.	7.00	2.50	3.00
28. Remove 36-in. c. i. pipe	2,760 l. f.	4.00	3.00	4.50
29. Pipe railing	710 l. f.	3.00	3.00	3.00
30. Alter Minersville Pumping Station	L. S.	45,000.00	45,000.00	35,000.00



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The common Water Works Trouble offer stiff opposition to any pipeline, but for years Lock Joint Concrete Pipe has successfully defeated these hard-hitting vandals.

Quality, workmanship and design have brought this pipe to the forefront in its field. Scores of years of trouble-free operation are built into every pipe. This powerful combination keeps a Lock Joint Pipeline ahead of its opposition and well able to overcome Water Works Troubles for countless seasons to come.

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JENKINS BROS., 80 White Street, New York, N.Y.
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(News continued from page 37)

MEN AND JOBS

FRANK R. BURNETTE, assistant chief engineer with the American Steel & Wire Co., Cleveland, has been employed by the Carnegie-Illinois Steel Corp. as construction superintendent. Burnette graduated from Ohio Northern University in 1910 with a civil engineering degree. He joined the American Steel & Wire Co. in 1916. Carnegie-Illinois also announced the appointment of HOWARD L. DAWSON as engineer of repairs, maintenance and lubrication. Dawson is a graduate of Carnegie Institute of Technology.

T. C. SMITH, chief engineer of the Clearwater Valley Light & Power Association of Lewiston, Idaho, has been appointed distribution engineer for the Bonneville administration with headquarters in Portland, Ore. Smith was employed by the Seattle, Wash., municipal lighting department from 1906-1918. He once served as chief engineer for the Orcas Power & Light Co. and in a similar capacity with the Idaho County Light & Power Association, Grangeville, Idaho.

W. OELKLAUS, secretary of the St. Charles, Mo., board of public works, was recently named superintendent of the St. Charles water works to succeed Walter Huffmeier.

BERRY B. CRAVEN, valuation engineer in the city assessor's office at St. Louis, has been appointed executive secretary of the St. Louis housing authority. The St. Louis Authority is to construct two low-rent housing developments at a total cost of about $7,000,000.

COMM. A. G. BISSET, civil engineering corps, U. S. Navy, has been transferred from the Naval Academy at Annapolis, Md., to do duty as public works officer at the Navy Yard, Portsmouth, N. H. Bisset is a graduate of Lafayette College. Early in life Commander Bisset worked for the Pennsylvania R. R., joining the navy in 1918 as assistant civil engineer. For four years he also served as treaty engineer for the Republic of Haiti.

COMM. C. H. COTTER, civil engineering corps, U. S. Navy, has been transferred from the Navy Yard, Portsmouth, N. H., to do duty as officer in charge of construction, on the naval air base at Jacksonville, Fla. Commander Cotter is a civil engineering graduate from the University of Michigan and for a time served as city engineer at Flint, Mich., joining the civil engineering corps of the navy in January, 1918.

COMM. C. R. JOHNSON, civil engineering corps, U. S. Navy, has been transferred from the Navy Yard at Philadelphia, Pa., to duty as public works officer at the Naval Academy, Annapolis, Md.

COMM. T. A. HARTUNG, civil engineering corps, U. S. Navy, has been transferred from the Navy Yard, Puget Sound, Wash., to do duty at Pearl Harbor, T. H.

COMM. H. W. JOHNSON, civil engineering corps, U. S. Navy, is now officer in charge of construction of the naval air base at San Juan, P. R., and submarine base, Saint Thomas, V. I. Previously Commander Johnson was stationed at the navy yard, New York City.

WILLIAM FLESHER, Philadelphia, Pa., has been appointed a member of the engineering staff of the Pennsylvania General State Authority.

RICHARD HAND, Wilkes-Barre, Pa., recently begun new engineering duties with the Pennsylvania Department of Forests and Waters.

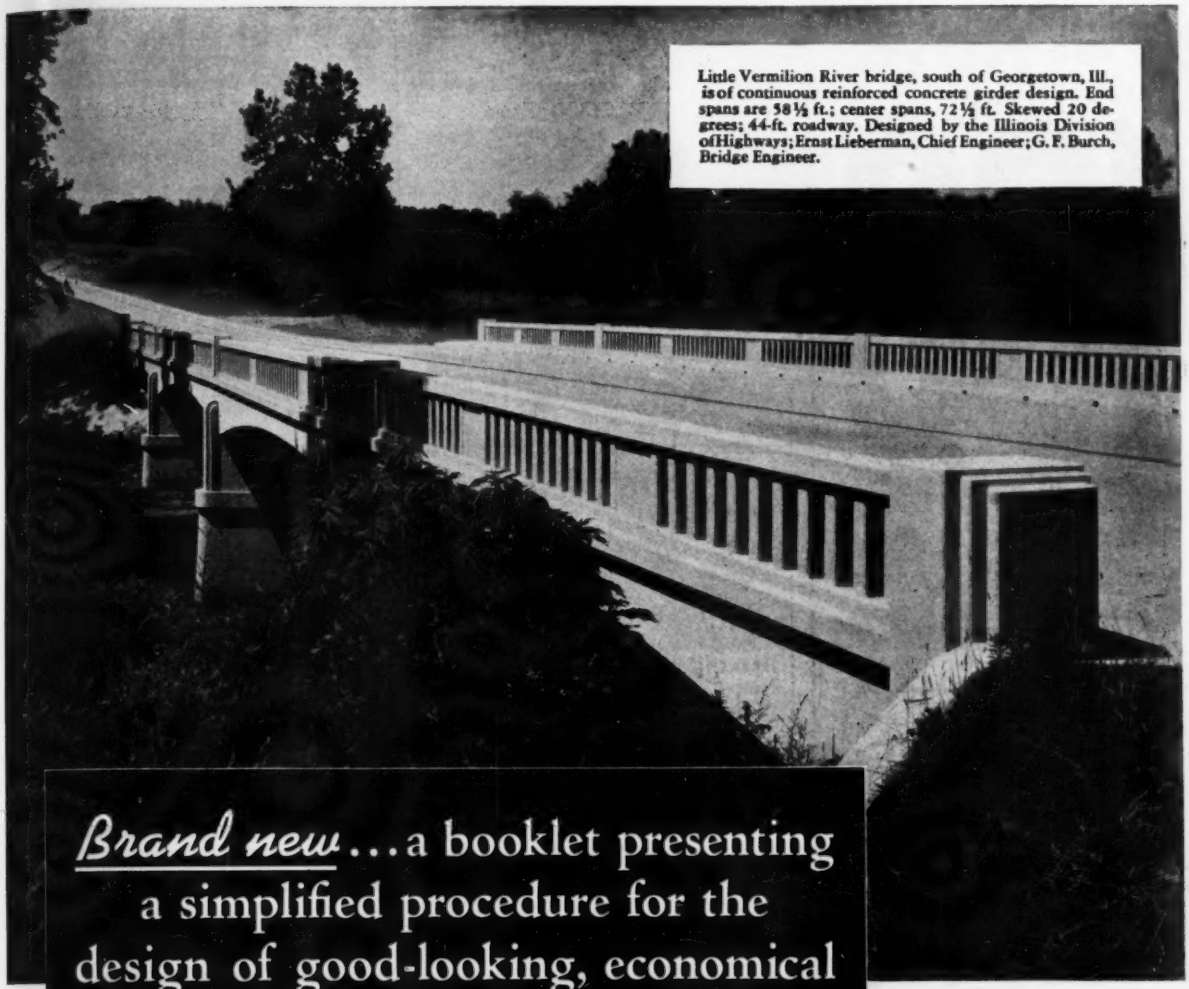
ALFRED N. MCCANDLISS, Pittsburgh, Pa., and ANDREW J. WHITNEY, JR., Rome, Pa., are new appointments on the engineering staff of the Pennsylvania State Highway Department. McCandliss is working as project engineer and Whitney is employed as assistant construction engineer.

PIERRE WARREN, civil engineer, has been made town engineer at Rouyn, Que.

JAMES C. LONG, Birmingham, Ala., has been appointed highway engineer for Cherokee County, Ala. He will serve until January 1943 and the appointment was made under an act recently passed by the legislature providing a highway engineer for every Alabama county.

PAUL EMILE COTE, Nov. 8, began duties as provincial minister of roads and public works for Quebec.

A. J. HAWKINGS has been elected director of the Alabama State Planning Commission, which was recently cre-



Little Vermilion River bridge, south of Georgetown, Ill., is of continuous reinforced concrete girder design. End spans are 58½ ft.; center spans, 72½ ft. Skewed 20 degrees; 44-ft. roadway. Designed by the Illinois Division of Highways; Ernst Lieberman, Chief Engineer; G. F. Burch, Bridge Engineer.

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CHARACTERISTICS

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BLOWS PER MINUTE

USES 25% TO 35% LESS
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ated by an act of the state legislature. Hawkins was once city engineer at Birmingham and since then has been connected with various federal projects in an engineering capacity.

CAPT. JAMES S. STRATTON, assistant engineer at Denison, Texas, U. S. Engineers, has been appointed district engineer at Conchas Dam, N. Mex., to succeed CAPT. HANS KRAMER. Kramer was recently transferred to the Canal Zone (*E.N.R.* Nov. 9, 1939, p. 94).

I. R. TAIT has been appointed chief engineer of the Canadian Industries, Ltd. to succeed L. DEB. MCCRADY.

MEETINGS

HIGHWAY RESEARCH BOARD, annual meeting, National Academy of Sciences, Washington, D. C., Dec. 5–8.

MEXICO DEPARTMENT OF PUBLIC HEALTH, first national convention of sanitation engineers, Mexico City, Dec. 18-20.

REGIONAL AND LOCAL

THE MOLES SOCIETY, quarterly meeting and dinner, Roosevelt Hotel, New York City, November 29.

NEBRASKA IRRIGATION ASSOCIATION, annual convention, North Platte, Nebr., Dec. 7–8.

EASTERN PHOTOELASTICITY CONFERENCE, Massachusetts Institute of Technology, Cambridge, Mass., Dec. 9.

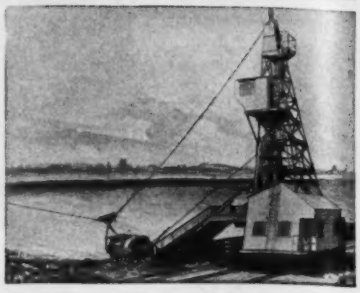
ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Carolinas branch, annual convention, Columbia, S. C., Dec. 14-15.

ELECTIONS AND ACTIVITIES

MAURICE W. WILLIAMS, consulting engineer in charge of railroad relocation plans at Niagara Falls, N. Y., spoke recently before the Niagara County, N. Y., chapter of the American Society of Professional Engineers. He explained that the cost of relocating tracks in the Niagara Falls area was estimated at $7,530,000 and estimated the grade crossing elimination work at $11,681,000.

WATER CONSERVATION and development through the cooperation of state and federal agencies took the spotlight in the second annual meeting of the South Dakota Reclamation Association held recently at Rapid City, S. D. Among the speakers on the program were Ross D. Davies, state coordinator;

SAUERMAN
LONG RANGE MACHINES



Sauerman Tower Excavator makes a long cut and loads material direct into cars. One of these machines, equipped with a 15 cu. yd. Crescent scraper bucket, will dig and load as much as 700 cu. yd. per hour. Capacities of smaller sizes are in proportion.

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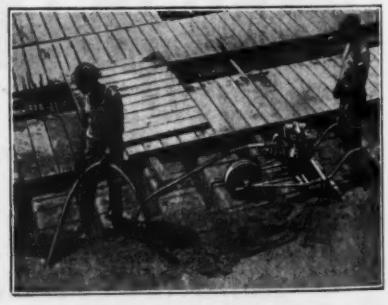
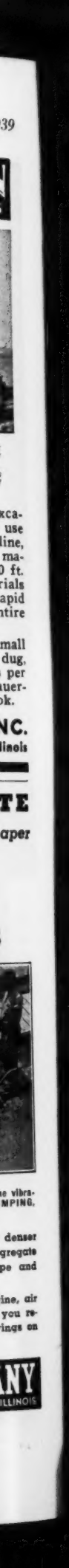
TRADE MARK
VIBRATORS



Pneumatic wheel mounted 3 H.P. gasoline engine vibrator. Can also be used for SURFACING, PUMPING, SAWING, GRINDING and DRILLING.

Get better bond with reinforcement—get denser and stronger concrete — eliminate aggregate pockets and expensive patching. A type and size for every job!

Send for circulars on the many gas engine, air and electric models, and let us advise you regarding the proper unit for greatest savings on your work.

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